United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R08-86/008
September 1986

EPA

Superfund Record of Decision:

Marshall Landfill, CO

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA/ROD/R08-86/008		

4. TITLE AND SUBTITLE	5. REPORT DATE
SUPERFUND RECORD OF DECISION Marshall Landfill, CO	September 26, 1986
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. TYPE OF REPORT AND PERIOD COVERED Final ROD Report 14. SPONSORING AGENCY CODE 800/00

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The Marshall Landfill, located three miles southeast of Boulder, Boulder County, CO, consists of two parcels: an 80-acre active County landfill and an 80-acre inactive landfill due north. Between 1965 and 1974, the inactive landfill accepted unstabilized sewage sludge and many unidentified and potentially hazardous wastes. Septic wastes and possibly liquid industrial wastes were also disposed offsite in two, now closed, septic ponds. Since 1974, the active landfill has accepted sewage sludge and municipal waste. (Industrial waste may have been accepted during the early years of operation.) Since 1975 the active landfill has been operated by Landfill Inc. (LI), a wholly-owned subsidiary of Browning-Ferris Industries (BFI). Prior to 1978, County inspectors observed landfill leachate seepage into Community Ditch, a conveyor of potable water from nearby Marshall Lake to the City of Louisville and irrigation water for the Farmers Reservoir and Irrigation Co. Two remediation actions have been taken subsequent to the July 1982 EPA proposal for inclusion on the NPL: a mid-1983 Cooperative Agreement to which LI agreed to install a pipeline to convey water from Marshall Lake across the inactive landfill and conduct an RI/FS; and an October 1983 order by EPA to LI to install the above mentioned pipeline, and to submit to EPA data and reports prepared pursuant to the Cooperative Agreement. The primary contaminants of concern include: VOCs including TCE, PCE, DCE, and benzene, and heavy metals including cadmium and lead. (See Attached Sheet)

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Record of Decision Marshall Landfill, CO Contaminated Media: gw, sw Key contaminants: VOCs, TCE, PCE, DCE, lead, cadmium, heavy metals		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
	None	54
	20. SECURITY CLASS (This page)	22. PRICE
	None	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

16. ABSTRACT (continued)

The selected remedial action includes: installation of a subsurface collection system using natural ground water gradients to collect all contaminated ground water leaving the Marshall Landfill site; treatment of contaminated ground water by sedimentation, air stripping, and off-gas carbon adsorption; landfill improvements, including regrading, revegetation, perimeter ditches, and fences, to minimize future environmental and public health impacts from the site; and ground and surface water monitoring. The estimated capital cost for this remedy is $1,819,000 with annual O&M costs of $1,152,000.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
ONE DENVER PLACE — 999 18TH STREET — SUITE 1300
DENVER, COLORADO 80202-2413

Record of Decision

Remedial Alternative Selection

Site

Marshall Landfill
Boulder County, Colorado

Documents Reviewed

I am basing my decision primarily on the following documents describing the analysis of the cost and effectiveness of remedial alternatives for the Marshall Landfill:

- Marshall Landfill Remedial Investigation, January 1985, prepared by Landfill, Inc., a responsible party.

- Marshall Landfill Feasibility Study, prepared by Landfill, Inc., a responsible party.
  - Task I: Initial screening of Remedial Technologies and Development of Alternatives, July 1985.
  - Task II: Detailed Evaluation of Remedial Alternatives, May 1986.

- Final Responsiveness Summary for Marshall Landfill Site, April 1986, prepared for EPA Region VIII by Camp, Dresser & McKee (attached)

- Memorandum dated June 16, 1986, from James Baker to Liz Evans pertaining to a toxicological evaluation of the Marshall Feasibility Study.

- Memorandum dated June 12, 1986, from Acting Director, Office of Health Assessment, Agency for Toxic Substances and Disease Registry, Department of Health and Human Services, to Michael A. McGeehin, Public Health Advisor, EPA Region VIII, pertaining to a health assessment of the Marshall Landfill.

- Draft Risk Assessment, Marshall Landfill, August 1985, prepared for EPA Region VIII by PRC Engineering.

- Report of Sampling Activities at the Deep Well Adjacent to Marshall Landfill, October 1984, prepared for EPA Region VIII by Ecology and Environment.

- National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300.

- Summary of Remedial Alternative Selection, EPA Region VIII, September 15, 1986 (attached).

Description of Selected Remedy

The EPA preferred alternative for Marshall Landfill includes final destruction of the contamination emanating from the site. As required by 40 C.F.R. section 300.68(f), this alternative attains or exceeds applicable or relevant and appropriate Federal public health or environmental standards that have been identified. By attaining these standards, this alternative effectively minimizes the release of hazardous substances into the environment so that they do not migrate to cause substantial danger to present or future public health, welfare, or the environment (40 C.F.R. 300.68 (a)(1)). The preferred alternative entails:

- a subsurface collection system using natural ground-water gradients to collect all contaminated ground water leaving the Marshall Landfill site;

- treatment of contaminated ground water by sedimentation, air stripping, and off-gas carbon adsorption to meet clean-up criteria established in the "Summary of Remedial Alternative Selection"; and

- landfill improvements, including regrading, revegetation, perimeter ditches, and fences, to minimize future environmental and public health impacts from the site.

Operation and maintenance requirements are an integral part of the EPA preferred alternative. An extensive network of environmental monitoring points, including surface water, ground water, and treatment system influent and effluent, has been developed to assure that EPA has adequate knowledge of the performance of the preferred alternative and of the ultimate environmental remediation. The contamination treatment system will remain in operation until monitoring shows that off-site ground-water standards are achieved.

The EPA preferred alternative thus provides for final destruction of the contamination at the Marshall Landfill site utilizing proven and effective engineering and geotechnical practices.

The preferred alternative includes off-site monitoring to establish whether or not off-site sources of contamination exist and are degrading the environment. These monitoring data will be used to determine if further response actions will be necessary. If so, this will be addressed in a subsequent decision document.

Declarations

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. section 9601 et seq., and the National Contingency Plan (40 C.F.R. Part 300), I have determined that the selected remedy at the Marshall Landfill is cost-effective and consistent with a permanent remedy that provides adequate protection of public health, welfare, and the environment. The State of Colorado has been consulted and agrees with the approved remedy. In addition, the action will require future operation and maintenance activities to ensure the continued effectiveness of the remedy. These activities will be considered part of the approved action. EPA has not reached agreement with the responsible parties at the site to implement the selected remedy.

Potential off-site sources of contamination will be monitored. Subsequent response action will be considered if the monitoring shows contamination above the clean-up criteria.

I also have determined that the action being taken is a cost-effective alternative when compared to the other remedial options reviewed.

Alexandra B. Smith — September 26, 1986

John G. Welles — Date
Regional Administrator
EPA Region VIII

Attachments

ROD ISSUES ABSTRACT

Site: Marshall Landfill, Boulder County, Colorado

Region: VIII

Briefing for Regional Administrator: September 10, 1986

Site Description

The Marshall Landfill, located southeast of Boulder in Boulder County, consists of an active designated County landfill and an inactive landfill due north. The inactive landfill and the active landfill accepted municipal waste, sewage sludges, and possibly industrial solvent wastes. Alluvial and deep bedrock ground waters are the principal contaminant migration pathways that could lead to public exposure to the contaminants. Consumption of alluvial ground water on-site or adjacent to the site would result in a greater than 10^{-6} incremental cancer risk or other non-carcinogenic health effects. The active landfill is operated by Landfill Inc. (LI), a wholly-owned subsidiary of Browning-Ferris Industries (BFI).

Selected Alternative

The cost-effective remedial alternative selected for this site includes: fencing, regrading, and revegetating the site to restrict access and minimize infiltration; collection of contaminated ground water by a series of drains partially surrounding the site to eliminate off-site transport of contaminants via alluvial ground water; treatment of the ground water by air stripping with off-gas carbon adsorption to reduce the concentrations of the volatile organics in the ground water to the most conservative of the applicable or relevant and appropriate standards and criteria (and prevent the escape of volatile organics to the atmosphere); ground water and surface water monitoring to assess the effectiveness of the proposed remedial alternative. The total present worth cost of the selected alternative is $3,259,000 which includes $152,800 per year of operation and maintenance cost for thirty years.

ISSUES AND RESOLUTIONS	KEY WORDS
1. LI states in the FS that the slurry wall will provide minimal benefit in dewatering the site. The Agency's position is that the analysis lacks an adequate data base. The selected alternative includes additional field testing and analysis to assess the slurry wall potential to reduce	o Slurry Wall o Source Control

contaminant sources, long term operation and maintenance costs, and the potential for deep aquifer contamination. A favorable assessment would lead to modification of the selected alternative to include the slurry wall.

2. Effluent from the treatment facility will meet the most conservative of the applicable or relevant and appropriate water quality standards and criteria.

   - Ambient Water Quality Criteria
   - Cleanup Criteria
   - Drinking Water Standards

3. Capping of the landfill in accordance with RCRA closure requirements was rejected as a remediation option because infiltration is a minor component of the water balance at the site, the proposed regrading and revegetation of the site will further minimize infiltration, the ground water collection system will prevent contaminants from migrating beyond the RCRA compliance point, and the installation cost of the cap is high.

   - Capping
   - RCRA Closure Requirements

4. The alternative selected represents a technology that destroys hazardous wastes in that the off-gas carbon once saturated with contaminants is thermally regenerated.

   - Air Stripping

5. The selected remedial action addresses prevention of off-site contaminant migration from the inactive and active landfill. Because off-site contamination exists at this time and off-site sources are suspected, a monitoring program will be implemented to assess ground water quality changes off-site and thus provide data to determine if further corrective action will be appropriate. If a problem exists, EPA will consider further response action.

   - Deferred Decisions

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

Marshall Landfill
Boulder County, Colorado

SITE LOCATION AND DESCRIPTION

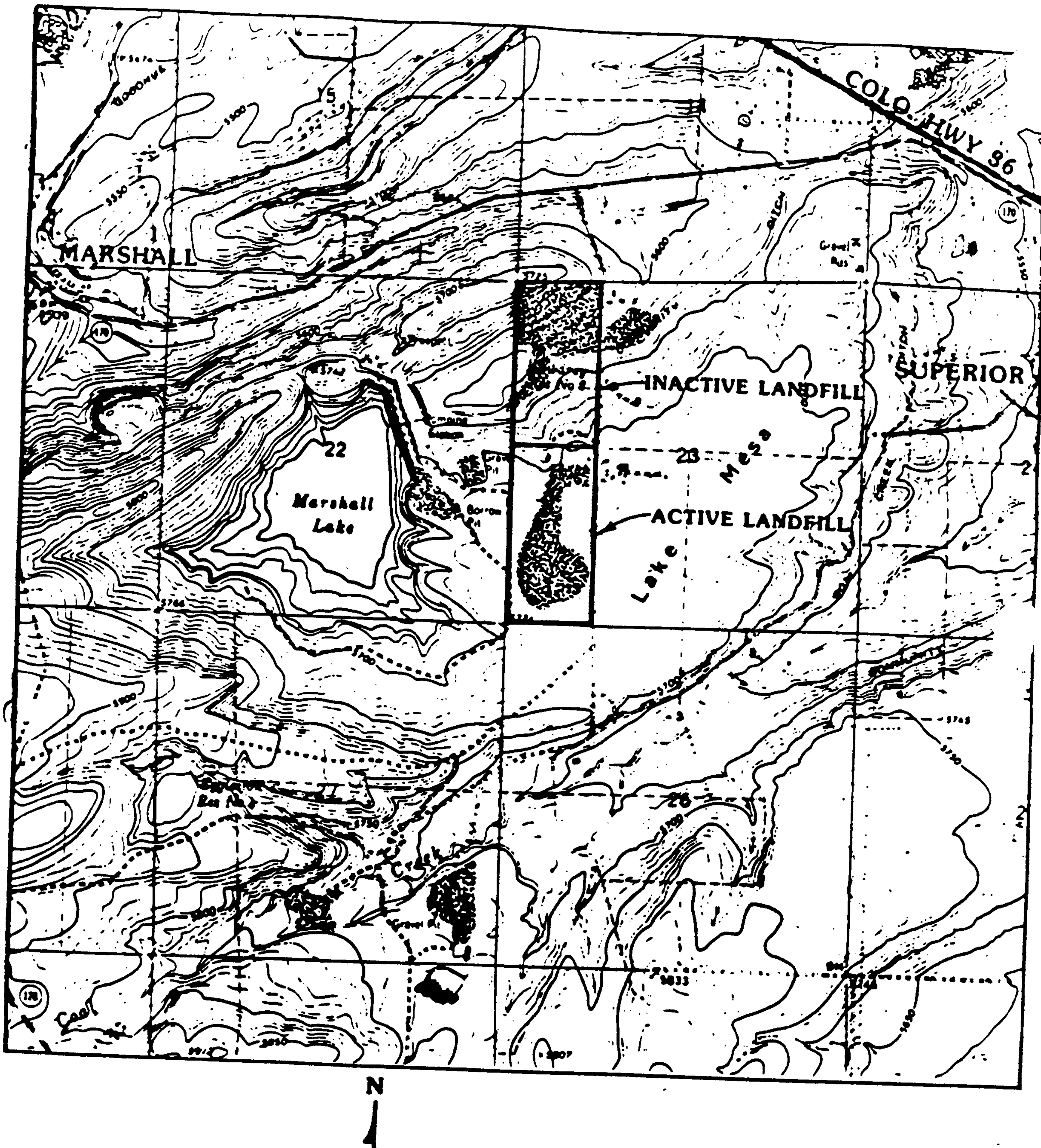
Marshall Landfill is in the western quadrant of Section 23, Township 1S, Range 70W in Boulder County, Colorado (Figures 1 and 2). Although the original Marshall Landfill designation spanned the entire north half of Section 23 (320 acres), only 80-acres in the western portion of the designation were intensively landfilled. This 80-acre portion is called the "inactive site". An additional 80-acres were added to the landfill in 1974. This area is in the western half of the southwest quadrant of Section 23, directly south of the 80-acre inactive site. The land added in 1974 is still being landfilled and is called the "active site". Together these two parcels comprise the 160-acre site which has been the focus of the remedial investigation/feasibility study.

Both the active and inactive landfills were designated County landfills under private operation. The various operators at the site are discussed in the following section, Site History. Property interest at the site is discussed in the Enforcement section.

The inactive landfill is in Cowdrey Drainage which conveys surface water from Cowdrey Reservoir No. 2 to South Boulder Creek. Community Ditch is also within the drainage and conveys potable water at various times of the year from Marshall Lake to the City of Louisville and irrigation water for the Farmers Reservoir and Irrigation Company. Additionally, two small lagoons, dug by Boulder County in an attempt to collect and contain landfill leachate, are on the inactive 80-acres.

With three exceptions, the area surrounding Marshall Landfill is used primarily for livestock grazing. These exceptions are: 1) a storage facility for the National Center for Atmospheric Research adjacent to the site on the east side of South 66th Street; 2) Marshall Lake, an irrigation and municipal drinking water reservoir, to the west; and 3) a small non-food warehouse building to the northeast that has been leased for a variety of storage uses.

The major population centers surrounding the site include the town of Marshall (1.5 miles west), the town of Superior (2 miles east), the city of Boulder (3 miles northwest), and the city of Louisville (3.5 miles northeast). The area within a one mile radius of the site is sparsely populated.



SCALE: 1 : 24,000

FIGURE 1

MARSHALL LANDFILL LOCATION MAP

REF: TASK 1

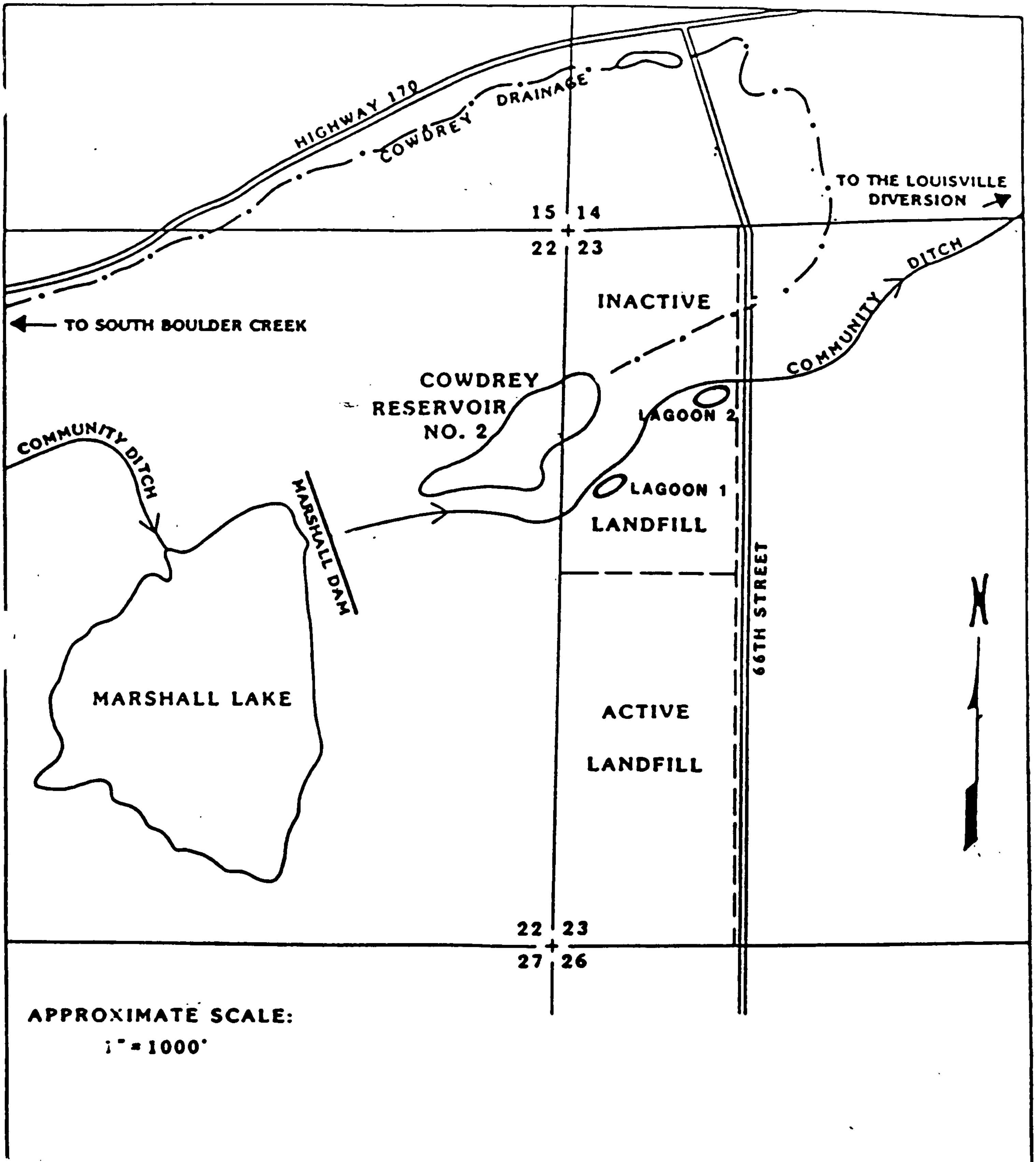


FIGURE 2

MARSHALL LANDFILL SITE DETAIL

REF: TASK 3 ADDENDUM RI/FS

SITE HISTORY

Landfill operations began at the Marshall site in 1965. The Richland Company of Colorado Springs leased the property from the Cowdrey Corporation, and under contract with the County Commissioners conducted the first official solid waste management operation from 1965 to 1969. The operations specified by the contract were the composting of solid waste. However, the company continuously lost money resulting in a poorly run operation with relatively little actual composting conducted during this period (less than 20%, the balance landfilled). In 1969, Salvage Inc. of St. Louis purchased the operation from Richland for the express purpose of landfilling, and soon thereafter entered into a joint venture with local investors and was renamed Urban Waste Resources (UWR). UWR operated the now inactive landfill from 1970 to 1974 under certification by Boulder County. In 1974, UWR in conjuction with Mesa Sand and Gravel expanded the operation to the south and abandoned the now "inactive" landfill. The combined sand and gravel excavation and landfilling to the south was operated under a Special Use Permit for which the first operations and monitoring plan was developed. In 1975, Landfill Inc. (LI) a wholly-owned subsidiary of Browning-Ferris Industries (BFI), purchased the operation and has operated the landfill ever since.

The inactive landfill accepted unstabilized sewage sludge and many unidentified and potentially hazardous wastes during its operation from 1965-1974. Prior to 1970, these wastes also were disposed in Cowdrey Drainage on the east side of South 66th St. between Community Ditch and Cowdrey Drainage. Septic wastes and possibly liquid industrial wastes also were disposed in the now closed septic ponds located east of South 66th St. and south of Community Ditch. The septic ponds were operated by the landfill operator.

Since 1974, the active landfill has accepted sewage sludge and municipal waste. Industrial waste may have been accepted during its early years of operation.

Investigations by EPA, the State, and the County have shown extensive contamination at the Marshall Landfill. As shown in Table 1, sampling and analysis of seeps, the leachate collection lagoons, a French drain along a segment of the western boundary, and alluvial ground-water monitoring wells within and adjacent to the 160-acre site indicate contamination in the alluvial aquifer. This contamination includes numerous volatile organics and heavy metals. The Remedial Investigation, conducted by LI also indicates trace organic contamination in the Laramie-Foxhills aquifer, a bedrock aquifer beneath the site. Surface water on the site, in Cowdrey Reservoir and the leachate lagoons is contaminated with heavy metals and organics (see Table 1).

Prior to 1978, County inspectors observed landfill leachate seeping into Community Ditch. In 1978, the Boulder County Commissioners established a "sinking fund" through a rate increase at

Table 1

MAXIMUM CONTAMINANT CONCENTRATIONS OBSERVED AT THE BOULDER/MARSHALL LANDFILLS

Parameter[1]	Surface Water[2]	Background Alluvial Ground Water	On-site Ground Water	Off-site Ground Water	Shallow Bedrock Ground Water	Deep Bedrock Ground Water
TDS*	1145	665	13200	420	2637	1770
Cl*	540	15	900	26	6	7
SO_4*	92	107	7900	100	6	23
NH_3*	57	-	120	0.1	0.3	0.3
Fe	510	110	58700	-	190	1100
Mn	580	39	6500	310	160	220
Ba	360	130	2000	600	120	160
Zn	31	80	250	97	25	6
As	-	-	50	-	-	-
Cd	-	-	33	-	18	-
Pb	-	-	60	-	15	-
Se	-	-	90	-	-	-
Hg	1.1	-	1.3	0.4	-	-
Cr	19	-	8	9	-	-
Phenols	19	-	2650	5	-	-
1,1-Dichloroethane	-	-	250	15 (77)	15	5
Trans 1,2-Dichloroethylene	-	-	530	66	9	-
1,1,1-Trichloroethane	-	-	49	- (550)	-	-
Trichloroethylene	-	-	93	6 (79)	-	-
Tetrachloroethylene	-	-	340	73 (98)	-	-
Dichloroethylene	-	-	-	- (79)	-	-
Ethyl Benzene	-	-	73	-	-	-
Toluene	-	-	1250	-	-	-
Benzene	-	-	43	-	-	-

[1] Values listed are in ug/l except for * which indicates values in mg/l
- Not Detected
  Values for Monitoring Well NA-9 in parentheses

[2] All water quality values are based on data obtained by the EPA's FIT Contractor (E & E, 1983 and 1985) or data obtained during the RI (Fox Consultants, Inc., 1983, 1984 a, b, & c)

REF: TASK 2 FS

the landfill to finance clean-up at the landfill. This fund is still in place.

In July 1982, EPA proposed Marshall Landfill for inclusion on the National Priorities List (NPL). At the time of the proposed listing, the site was the State of Colorado's highest priority for remediation under CERCLA. In September 1983, Marshall Landfill was included on the first NPL. The hazard ranking system (HRS) score for the site when listed was 46.52.

Subsequently, two actions were taken to initiate remediation at the site. First, in mid-1983, LI, Boulder County, the Colorado Department of Health (CDH), the City of Louisville, and the Farmers Reservoir and Irrigation Company signed a Cooperative Agreement. The Cooperative Agreement was entered into pursuant to beginning negotiations with EPA for the RI/FS and also a CDH notice of violation issued to LI under authority of the State Solid Waste Disposal Sites and Facilities Act, Title 30-20, Part 1, C.R.S. 1973 (as amended). LI agreed to implement remedial measures to protect Community Ditch water and conduct a remedial investigation and feasibility study (RI/FS). Community Ditch was to be protected by installation of a 60-inch pipeline to convey the water from Marshall Lake across the inactive landfill.

Second, in October 1983 EPA issued a unilateral CERCLA 106 Order to LI when negotiations broke down. The Order required LI to install the Community Ditch pipeline by April 1, 1984, and to submit to EPA all data generated and all reports prepared pursuant to the Cooperative Agreement.

CURRENT SITE STATUS

Results of the Remedial Investigation

Several reports prepared pursuant to the Cooperative Agreement comprise the Remedial Investigation for the site. The reports are:

- Task 1: Evaluation of Water Quality and Water Quality Monitoring at the Boulder Landfill, Boulder, Colorado, April 1983
- Task 2: Geologic and Hydrologic Data Collection at the Boulder Landfill, Boulder, Colorado, November 1983.
- Task 2: Addendum: Results of Additional Field and Laboratory Investigations Conducted April-August, 1984.
- Task 3: Site Characterization and Contaminant Migration Report for the Active Boulder and Inactive Marshall Landfills, Boulder County, Colorado, December 1983.
- Task 3: Addendum: Responses to Comments and Evaluation of 1984 Field and Laboratory Results, January 1985.

In addition, quarterly monitoring data collected over a period of 1 1/2 years were part of the Remedial Investigation.

Site Geology and Hydrology

This section is the site conditions summary of the FS prepared by Landfill, Inc.

The Marshall Landfill is between the crest of Lake Mesa and a small bedrock ridge along the north side of Marshall Lake (see Figure 1). Lake Mesa is a broad, upland pediment surface, consisting of a gravel capped bedrock erosional surface along the crest, a series of colluvial and terrace deposits along the flanks, and colluvial and weathered soil along Cowdrey Drainage. Refuse in the active landfill was placed across the top of Lake Mesa. Refuse within the inactive landfill was placed along the bedrock slope north of Cowdrey Drainage, down into Cowdrey Drainage, and up along the flank of Lake Mesa.

The bedrock geology of the area consists of a faulted sequence of Laramie Foundation and Fox Hills Sandstone. The continuity of the bedrock formations in this area has been severely disrupted by a series of northeast-trending, high-angle normal and reverse faults. The most prominent of these is the Crown Davidson Mesa fault which bisects the inactive landfill, dividing the landfill area into two distinct tracts. The first tract, located north of the fault and consisting of the northern portion of the inactive landfill, is interpreted to be underlain by a thick sequence of Laramie shale. The second fault block, which consists of the southern and central portion of the inactive landfill and the entire active landfill area, is interpreted to be up-thrown relative to the northern fault block and to be underlain by a thin sequence of Laramie Formation shales and coal measure rocks, the basal A and B sandstones of the Laramie Formation, and the Milliken Sandstone of the upper portion of the Fox Hills Sandstone (see Figure 3).

The surface water in the area of the landfill is dominated by Marshall Lake, a 240-acre irrigation and municipal water supply reservoir. The flow into Marshall Lake is derived primarily from Community Ditch, which collects surface water from South Boulder Creek approximately 4 miles west of the landfill. Outflow from the lake is dominated by flow within Community Ditch, which conveys water from the reservoir across the southern portion of the inactive landfill, along the northwest flank of Lake Mesa, and out onto the eastern plains of Colorado for agricultural uses and to the City of Louisville for municipal supply. Cowdrey Reservoir No. 2 is supplied primarily by seepage beneath Marshall Dam with a lesser contribution due to runoff from the surrounding 150-acre area and seepage and leachate discharge from the landfill itself. Outflow from Cowdrey Reservoir No. 2 occurs primarily as surface flow in Cowdrey Drainage. This drainage traverses the northern portion of the inactive landfill, across South 66th Street, and through the area of uncontrolled dumping

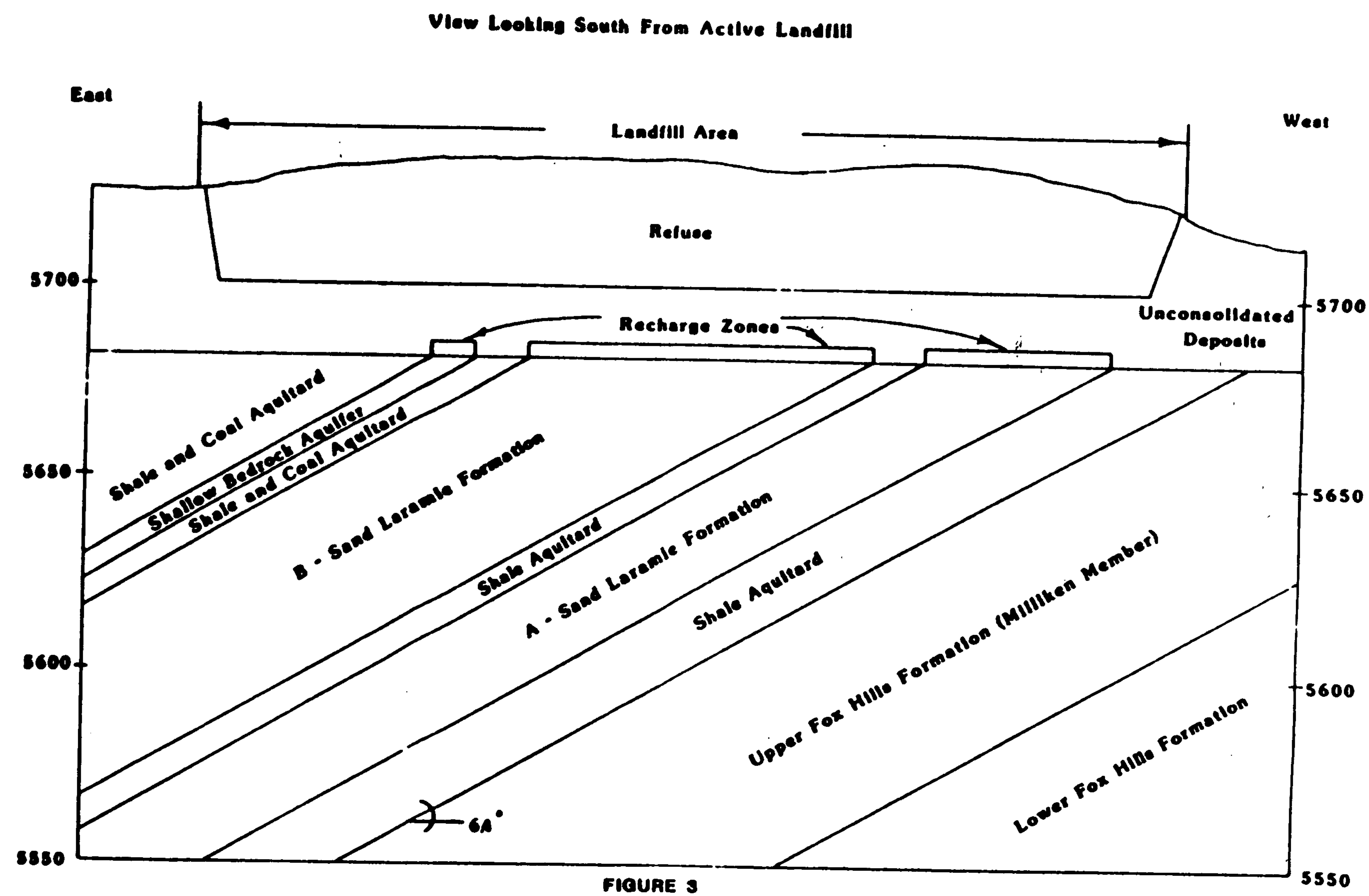


FIGURE 3
Horizontal Scale

0' 200'

Interpretive East, West Cross Section, Lake Mesa Fault Block, Boulder/Marshall Landfill on the east side of South 66th Street, where it reverses course back to the west to join South Boulder Creek 3 miles from the landfill area.

The uppermost hydrogeologic unit at the Marshall Landfill is an alluvial aquifer consisting of sands, gravels, and clays mantling the top and flank of Lake Mesa; colluvial material along the base of Lake Mesa; weathered bedrock in the low areas around Cowdrey Reservoir; alluvium along Cowdrey Drainage; and refuse that has been placed within the landfill area. Flow within the alluvial aquifer is generally to the north and northwest in the immediate vicinity of the landfill up to Cowdrey Drainage and to the south and southeast along the flank of the small ridge on the north side of Cowdrey Drainage (see Figure 4).

Bedrock aquifers beneath the site are dominated by the regional Laramie-Fox Hills aquifer of the Denver Basin. Beneath the southern portion of the inactive landfill and the entire active landfill, four distinct hydrostratigraphic units have been identified within the regional Laramie-Fox Hills aquifer. These consist of an upper shallow bedrock aquifer, the B sand of the Laramie Formation, the A sand of the Laramie Formation, and the Milliken member of the Fox Hills Formation. With the exception of the Milliken Sandstone, all of these units are inferred to outcrop beneath the landfill area. Each of these aquifers is separated by thin shale and shale and coal measure aquitards. These aquitards result in a complex pattern of vertical flow gradients. Beneath the eastern portion of the active landfill, flow is interpreted to be vertically downward through all four units. Beneath the western portion of the active landfill, flow is interpreted to be vertically upward from the A sand of the Laramie Formation. Beneath the southern portion of the inactive landfill, flow is interpreted to be vertically upward from the B sand of the Laramie Formation.

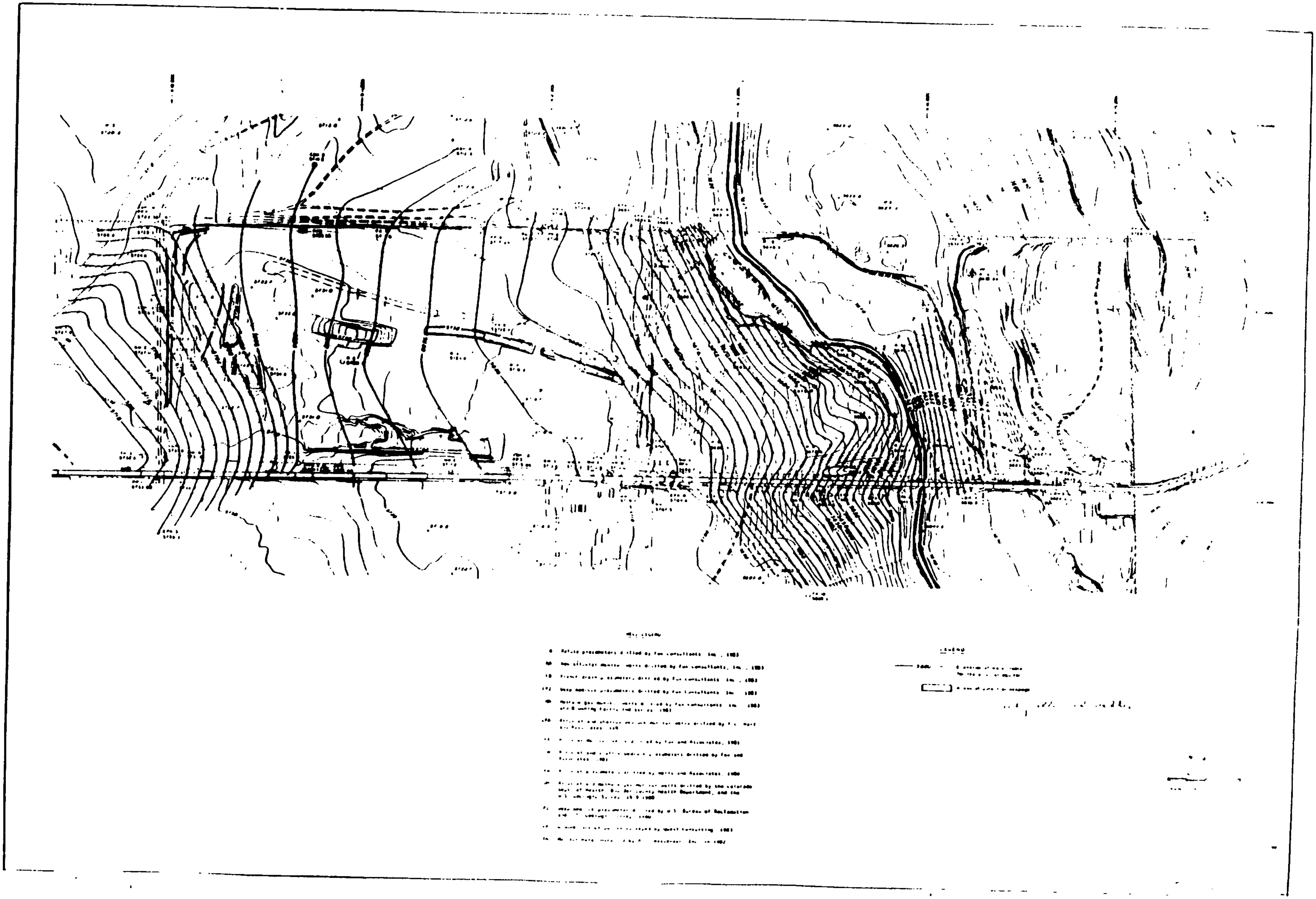
Site Contamination

Surface water and ground water on-site and ground water off-site at Marshall Landfill are contaminated (see Table 1). Contaminated surface water and ground water are characterized by elevated concentrations of major ions, heavy metals, and by the presence of priority pollutant volatile organic compounds. The maximum contaminant concentrations in on-site alluvial ground water are above water quality standards and guidelines (See Table 7).

Figure 5, from the RI prepared by LI, shows the known extent of alluvial ground water contamination. Several items are noteworthy here. The alluvial ground water of the southern sector of the inactive landfill has the most degraded water quality. Contamination occurs off-site to the east despite the fact that groundwater gradients are to the north-northwest (see Site Geology and Hydrology Section). Two potential off-site sources of contamination east of South 66th Street are suggested:

FIGURE 4

WATER TABLE MAP OF ALLUVIAL AQUIFER



REF: TASK)UM RI/FS

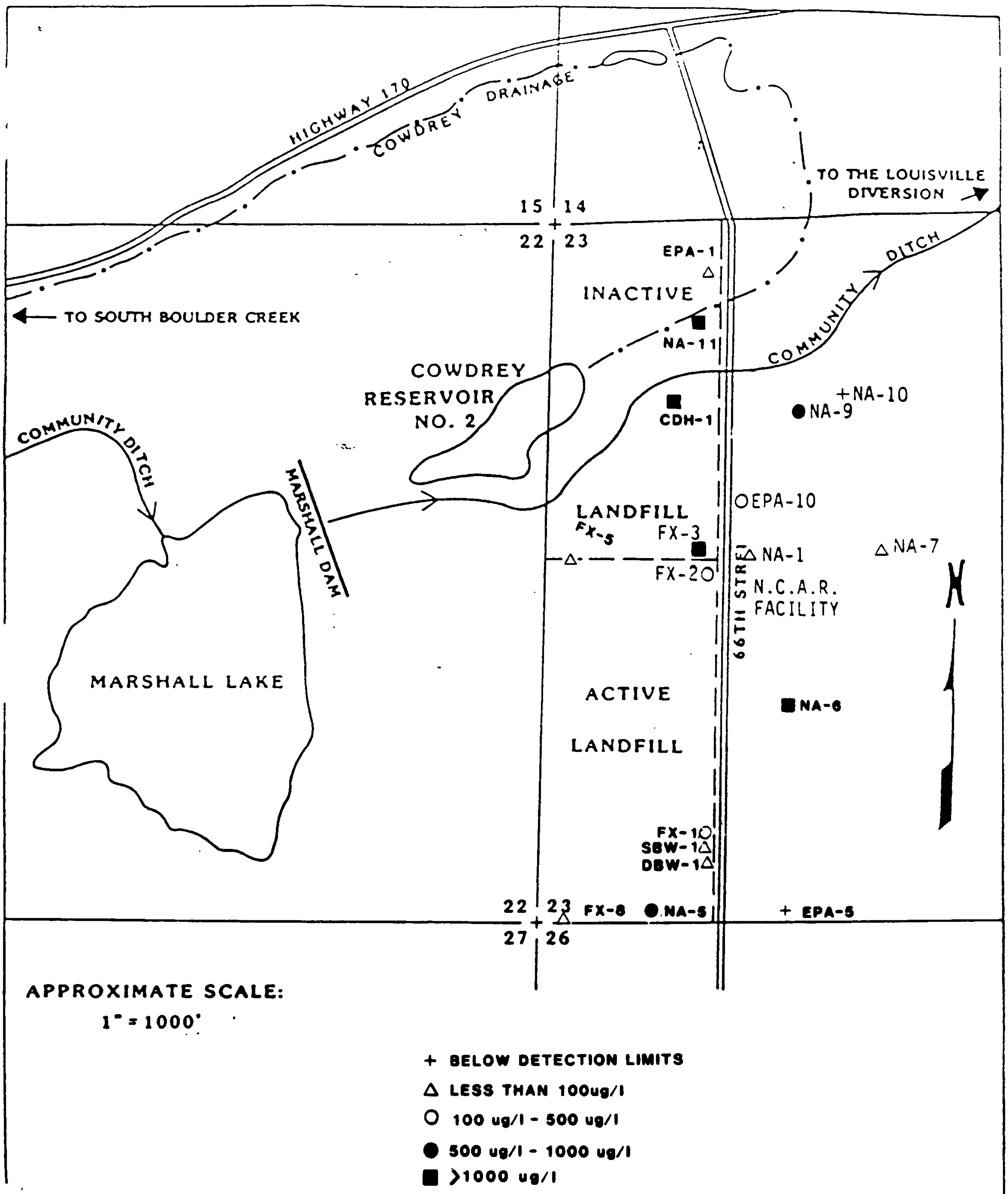


FIGURE 5

MAXIMUM TOTAL VOLATILE ORGANIC CONCENTRATIONS

one at the now-closed septic ponds and the other in the vicinity of monitor well NA-6.

Piezometric head data indicate a potential for contaminated recharge of the sandstone aquifers in the east-southeast portion of the active landfill, and potential for recharge of the landfill refuse and alluvium from the Laramie sandstones in the other areas of the landfill. Monitoring data for the shallow bedrock well (SBW-1) and the deep bedrock well (DBW-1) located in the east-southeast sector of the active landfill (see Figure 5) indicate trace levels of 1,1-dichloroethane. This may be evidence of bedrock aquifer contamination resulting from contaminated alluvial ground water recharge of these units.

There is no apparent threat to users of surface water originating in Marshall Lake and passing through the site as contaminants were not detected in the waters leaving the site via Cowdrey Drainage or Community Ditch during the conduct of the Remedial Investigation. After completion of the Remedial Investigation, the Fall 1985 sampling and analysis indicated 5ug/1 of 1,1-dichloroethane in Cowdrey Drainage surface water where it crosses the section line to the northeast. This concentration is the method detection limit and is the first occurrence of priority pollutant contamination in Cowdrey Drainage surface water off the 160-acre site.

Migration Pathways and Potential Receptors

LI prepared a public health evaluation in accordance with EPA guidance for performing feasibility studies. LI selected indicator parameters based upon whether they met 3 or more of the 4 following criteria: frequently detected, present in more than one hydrologic media, occurrence at concentrations above standards or proposed health advisories, and availability of toxicity data. The selected parameters were benzene, trichloroethylene (TCE), tetrachloroethylene (PCE), 1,2- dichloroethylene (1,2-DCE), cadmium, and lead.

There are documented human health effects resulting from exposure to benzene either by inhalation, ingestion, or skin contact. The most notable health effect resulting from exposure to benzene is its carcinogenic potential. Benzene is classified as a positive human carcinogen based upon epidemiological data from occupational exposure. Benzene occurs in alluvial ground water on-site at concentrations in excess of the Clean Water Act (CWA) water quality criterion based on a 10^{-6} incremental cancer risk.

Human exposure to TCE can occur by either inhalation, ingestion, or skin contact. Prolonged or repeated skin contact to TCE can result in dermatitis. Although numerous non-carcinogenic health effects can result from inhalation or ingestion of TCE, the primary concern with respect to TCE is its carcinogenicity. EPA has classified TCE as a suspected human carcinogen. TCE is present in alluvial ground water within or adjacent to the site at concentrations in excess of the CWA water quality criterion based on a 10^{-6} incremental cancer risk.

The primary human exposure route for PCE is inhalation or ingestion. Similar to TCE, PCE exposure can result in many non-carcinogenic health effects. The most noted concern is the fact that it is a suspected animal carcinogen. EPA considers it to be a potential human teratogen. PCE occurs in alluvial ground water within and adjacent to the site at concentrations above the 10^{-6} incremental cancer risk criterion.

Sleepiness and hallucinations can result from inhalation of 1,2-DCE. There is no information on health effects resulting from oral exposure. 1,2-DCE occurs in alluvial ground water within the site at concentrations in excess of the Recommended Maximum Contaminant Level (RMCL).

The primary human exposure route for cadmium is ingestion. Non-carcinogenic health effects from cadmium exposure include renal tubular dysfunction, bone damage, hypertension, anemia, sensory loss, endocrine alterations, and immunosuppression. Cadmium is a suspected carcinogen and a known animal teratogen. Cadmium is present in on-site alluvial ground water at concentrations in excess of the primary drinking water standard.

The primary human exposure route for lead is also ingestion. Lead is known to have toxic effects on the hematopoietic system and nervous system. Lead exposure to children and pregnant women has been linked to decreased learning ability of the affected child. Lead can also be an animal carcinogen and teratogen, in certain forms. Lead occurs in on-site alluvial ground water in concentrations in excess of the drinking water standard.

There are four communities near the landfill. These are the towns of Superior (1.5 miles east of the landfill), Marshall (1.5 miles west), Louisville (3.5 miles northeast), and the City of Boulder (3 miles northwest). The estimated 1985 populations and projected populations for the year 2000 for these communities are as follows (Boulder County Planning Commission, 1985):

Community	1985 Population (estimated)	2000 Population (projected)
Boulder	96,500	122,200
Louisville	9,500	17,000
Superior	500	1,000
Marshall	250	500

In addition to the residents of the area around the landfill, a number of people travel to the immediate vicinity of the landfill for recreational or business purposes. Primarily, these include recreational users of the Louisville Rod & Gun Club, who use property near Marshall Lake; employees of the National Center for Atmospheric Research (NCAR); workers engaged in cattle management in the area; and those employees of Farmer's Reservoir and

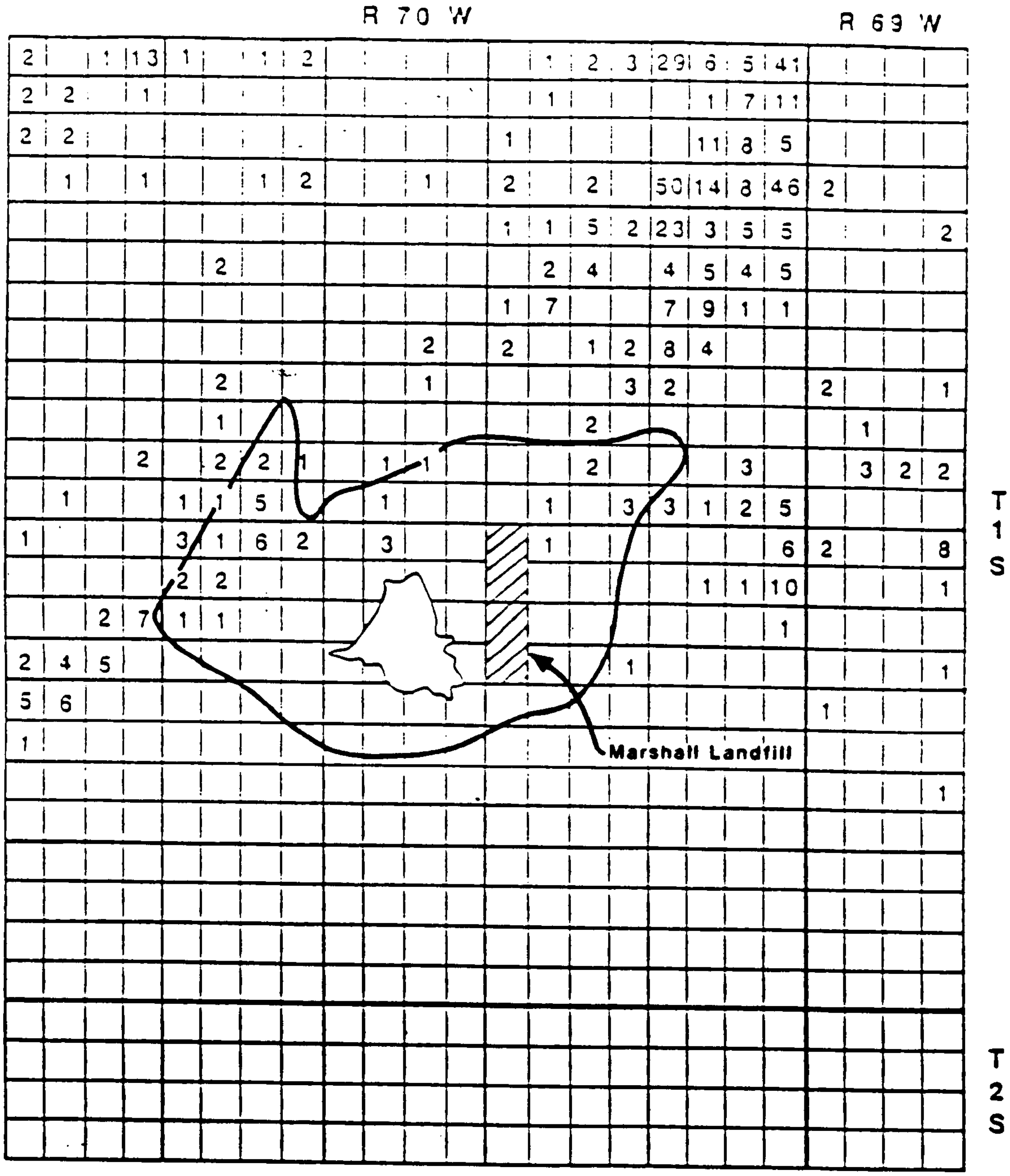
Irrigation Company involved in the operation of Marshall Dam and Community Ditch.

The LI FS estimates that there are 558 established wells within a 3-mile radius of the landfill, 96% of which are used for domestic purposes only and 4% of which are used for commercial or municipal purposes (see Figure 6). Of the 558 wells, 251 are alluvial wells. The rest are completed in the underlying Laramie Fox Hills aquifer.

The first potential pathway of contaminant transport is alluvial ground water. The LI FS states that the alluvial wells within a 3-mile radius of the landfill are isolated from the contamination bearing alluvial ground waters associated with the site (see Figure 6). While there are no alluvial wells in Cowdrey Drainage registered with the Colorado State Engineers office, the extent of off-site contamination along Cowdrey Drainage is unknown and, therefore, care must be taken with this potential pathway. Lifetime consumption of alluvial ground water on site and along the boundaries of the site would result in a greater than 10^{-6} incremental cancer risk due to ingestion of benzene, trichloroethylene, and tetrachloroethylene, and could produce non-carcinogenic health effects from ingestion of lead, cadmium, trans-dichloroethylene, trichloroethylene, and tetrachloroethylene whose concentrations exceed either the primary drinking water standards, ambient water quality criteria, health advisories, and/or adjusted acceptable daily intakes (see Tables 1 and 7). Provisions for further monitoring of this pathway are included in the preferred alternative.

A second potential pathway of contaminant transport is the bedrock groundwater beneath the landfill. As stated in the LI RI/FS, trace levels of volatile organic compounds have been detected in the shallow and deep bedrock aquifers beneath the site. These are 1,1-dichloroethane and trans 1, 2-dichloroethylene (see Table 1). The shallow and deep bedrock aquifers described in the RI/FS are part of the Laramie Fox Hills Aquifer. The Laramie-Fox Hills Aquifer is used for drinking water purposes. Within a 3-mile radius of Marshall Landfill, 307 wells are completed in the Laramie-Fox Hills Aquifer. The risks from this potential pathway are not quantified because the contaminant concentrations are below water quality standards.

A third potential pathway of contaminant transport is the surface water leaving the site via Cowdrey Drainage and Community Ditch. Water from Community Ditch is used as a drinking water source by the City of Louisville. Although Community Ditch was replaced with a pressurized pipeline where it traverses Marshall Landfill, ground water continues to seep into Community Ditch east of the landfill. The LI RI/FS monitoring data show trace levels below clean-up criteria of hazardous substances, pollutants, and contaminants in Cowdrey Drainage. Cowdrey Drainage, tributary to South Boulder Creek, is a water body subject to stream standards for South Boulder Creek imposed by the State of Colorado. South Boulder Creek is classified by the State of Colorado as Class I



EXPLANATION

Boundary of Alluvial Basin Containing Marshall Landfill

Marshall Landfill

(After State Engineers Office & HLA Field Inspections)

FIGURE 6

REF: FINAL FS

DISTRIBUTION (by Quarter Section) OF EXISTING WELLS WITHIN 3-MILE RADIUS OF MARSHALL LANDFILL

recreational (primary contact, i.e. swimming), Class I cold water aquatic life, water supply (domestic use) and agriculture.

The Agency for Toxic Substances and Disease Registry (ATSDR) reviewed the sampling data from the site and has proposed recommendations for further investigation. These recommendations include sampling off-site wells used for drinking water, determining ground water users near the site that may be impacted by the site, confirming the extent of alluvial and deep bedrock contamination, assuring the remediation system intercepts the plume, assuring that metal contamination is adequately addressed in the proposed ground water treatment system, soil sampling in areas of exposed refuse, air sampling to assess volatile organic concentrations in the air, and estimating the impact on air quality of air stripping of volatile organics. The ATSDR agrees that collection of ground water along the eastern boundary of the site with subsequent treatment will minimize exposure of the nearby population to the contaminants.

ENFORCEMENT - see Enforcement Confidential Attachment

ALTERNATIVES EVALUATION

LI designed the FS to evaluate remedial action alternatives that met the following four objectives as outlined in the in the "Feasibility Study, Task 1 Initial Screening of Remedial Technologies and Development of Alternatives":

1. Assure that all surface water discharge from the landfills does not adversely impact the current or planned future beneficial uses of the surface waters in this area or any other waters that it may contact;

2. Control the generation of contaminated ground water at the landfills;

3. Assure that any off-site contaminated ground water originating at the landfills does not adversely impact the possible beneficial uses of the ground waters in this area or any other surface waters and ground waters it may contact;

4. Eliminate or control the impacts resulting from leachate seepage in the landfills.

LI developed numerous remedial technologies potentially applicable to the response actions that address these objectives. In accordance with the National Contingency Plan (NCP) at 40 CFR 300.68 (f), remedial action alternatives that address the overall problem were developed by combining appropriate remedial technologies. In the development of the alternatives, consideration was given to meeting all the objectives and providing alternatives that fall into the five categories outlined at 40 CFR 300.68 (f), i.e., alternatives that consider offsite disposal at an EPA approved facility, attainment of applicable or relevant and appropriate federal public health and environmental requirements, exceedance of applicable or relevent and appropriate requirements, non-attainment of applicable or relevant and appropriate requirements but reduction of the threat from hazardous substance release, and no action. Tables 2 and 3 present the 16 alternatives that were developed and how they address the above stated factors.

In accordance with 40 CFR 300.68 (f) and (g), these alternatives were screened to narrow the list of alternatives to those that most closely met the NCP requirements and the site objectives. The screening process also eliminated alternatives offering similar levels of protection but were otherwise more difficlult to implement, more expensive, or posed significant adverse impacts. Four organizations, EPA, LI, CDH, and the Boulder County Health Department (BCHD) actively participated in the screening.

Alternative 2 was eliminated because of its high cost relative to Alternatives 6, 7, 9, 12, and 15, the latter alternatives offering similar benefits. Alternative 3 was eliminated because it only addressed one of the proposed response objectives, i.e., source control. Alternatives 4, 11, 13, and 14 were eliminated because they do not address existing ground water contamination. Alternative 8 and 10 differ only by the inclusion in Alternative 10 of surface water collection. Surface water collection via perimeter ditches would help reduce runon and thus infiltration at a low cost, therefore, Alternative 8 was eliminated on this basis. Alternatives 9 and 16 are similar to Alternative 15. However, unlike Alternative 15, Alternative 9 does not include surface water collection and treatment which would provide additional benefit at a low cost. It was therefore eliminated. Alternative 16 includes leachate collection which adds cost and increased exposure of workers to the contaminants relative to Alternative 15. Because leachate collection does not provide significantly greater benefits relative to Alternative 15, it was eliminated. Alternatives 6, 7, and 12 all include ground water collection and treatment. Because Alternative 7 also includes both surface water and leachate collection as opposed to Alternatives 6 and 12 which simply include one or the other, Alternatives 6 and 12 were eliminated from further consideration.

In summary, the alternatives retained for further evaluation are as follows:

- Alternative 1 - No action,
- Alternative 5 - Surface water and ground water collection and discharge,
- Alternative 7 - Surface water, ground water, and leachate collection, treatment, and discharge,
- Alternative 10 - ground-water barrier with surface water and ground water collection and discharge,

Table 2

APPLICATION OF PROPOSED REMEDIAL ALTERNATIVES TO PROPOSED REMEDIAL RESPONSE OBJECTIVES

Remedial Alternatives*	Response Objectives			
	Surface Water Control	Source Control	Off-Site Ground-Water Control	Leachate Seepage Control
1. No Action	-	-	-	-
2. Excavation	-	X	-	X
3. Ground-Water Barrier	-	X	-	-
4. Surface-Water Diversion, Collection, and Discharge and Ground-Water Barrier	X	X	-	-
5. Surface- and Ground-Water Collection and Diversion	X	X	X	-
6. Surface- and Ground-Water Collection and Treatment	X	X	X	-
7. Surface-Water, Ground-Water, and Leachate Collection and Treatment	X	X	X	X
8. Ground-Water Collection and Ground-Water Barrier	-	X	X	-
9. Ground-Water Barrier and Ground-Water Collection and Treatment	-	X	X	-
10. Surface- and Ground-Water Collection and Discharge with Ground-Water Barrier	X	X	X	-
11. Surface-Water and Leachate Collection and Discharge with Ground-Water Barrier	X	X	-	X
12. Ground-Water and Leachate Collection and Treatment	-	X	X	X
13. Ground-Water Barrier and Leachate Collection and Treatment	-	X	-	X
14. Partial Excavation and Ground-Water Barrier	-	X	-	X
15. Ground-Water Barrier with Surface-Water and Ground-Water Collection, Treatment and Discharge	X	X	X	-
16. Ground-Water Barrier with Surface-Water, Ground-Water, and Leachate Collection and Treatment	X	X	X	X

* Regrading and revegetating is to be considered a part of all alternatives.

Table 3

APPLICATION OF PROPOSED REMEDIAL ALTERNATIVES TO NCP-REQUIRED ALTERNATIVES

Proposed Alternative*	Off-Site Treatment/ Disposal	NCP Required Alternative: Attain Standards	Exceed Standards	Reduce Threat	No Action
1. No Action**	-	-	-	-	X
2. Excavation	X	-	-	-	-
3. Ground-Water Barrier	-	-	-	X	-
4. Surface-Water Diversion, Collection, and Discharge and Ground-Water Barrier**	-	-	-	X	-
5. Surface- and Ground-Water Collection and Diversion**	-		-	-	-
6. Surface- and Ground-Water Collection and Treatment**	-	-	X	-	-
7. Surface-Water, Ground-Water, and Leachate Collection and Treatment**	-	-	X	-	-
8. Ground-Water Collection and Ground-Water Barrier**	-	-	-	X	-
9. Ground-Water Barrier and Ground-Water Collection and Treatment**	-	X	-	-	-
10. Surface- and Ground-Water Collection and Discharge with Ground-Water Barrier**	-	-	-	X	-
11. Surface-Water and Leachate Collection and Discharge with Ground-Water Barrier	-	-	-	X	-
12. Ground-Water and Leachate Collection and Treatment**	-	X	-	-	-
13. Ground-Water Barrier and Leachate Collection and Treatment*		-	-	X	-

* Regrading and revegetating of the landfill cover is to be considered a part of all alternatives.

** Potentially applicable to both source control and management of migration; all others apply to source control only.

Table 3 (continued)

Proposed Alternative*	Off-Site Treatment/ Disposal	NCP Required Alternative Attain Standards	Exceed Standards	Reduce Threat	No Action
14. Partial Excavation and Ground-Water Barrier	-	-	-	X	-
15. Ground-Water Barrier with Surface-Water and Ground-Water Collection, Treatment and Discharge**	-	X	-	-	-
16. Ground-Water Barrier with Surface-Water, Ground-Water, and Leachate Collection and Treatment**	-	-	X	-	-

* Regrading and revegetating of the landfill cover is to be considered a part of all alternatives.

** Potentially applicable to both source control and management of migration; all others apply to source control only.

Alternative 15 - ground-water barrier with surface water and ground water collection, treatment and discharge.

These alternatives fall as appropriate into several of the categories specified at 300.68 (f):

(i) attain requirements and (ii) exceed requirements: Alternatives 7 and 15 attain and may exceed water quality criteria. The LI FS did not include RCRA standards with respect to treatment facility design, closure, and Subpart F ground water protection standards in the development of any of the alternatives;

(iii) do not attain requirements: Alternatives 1, 5, and 10 significantly reduce the release of hazardous substances but may not attain applicable or relevant and appropriate water quality criteria; and

(iv) no action: Alternative 1 represents the no action alternative.

Although off-site disposal is a category specified at 300.68 (f), excavation of the refuse with off-site disposal at a RCRA facility was eliminated on the basis of excessive cost without a corresponding significant improvement in benefits relative to the other alternatives considered.

The alternatives listed above were renumbered alternatives 1-5 in the document "Feasibility Study - Task II: Detailed Evaluation of Remedial Alternatives Boulder/Marshall Landfills, Boulder, Colorado". Table 4 presents the renumbered alternatives with associated capital, operation and maintenance, and present worth costs. A description of each of these alternatives is in this section.

In addition to these five alternatives, EPA developed a sixth alternative which is also described in this section. Table 4 also shows the capital, operation and maintenance, and present worth costs of this alternative.

EPA policy and NCP guidance require examination of innovative technologies that destroy hazardous substances as an alternative to land disposal. This is consistent with EPA policy to seek permanent solutions to environmental contamination as opposed to on-site or off-site disposal of hazardous materials. The EPA preferred alternative is designed to capture all contaminated ground water leaving the site. The contaminated ground water will then be treated by air stripping and carbon adsorption of the off-gases. The contaminants captured in the off-gasses will ultimately be destroyed during thermal regeneration of the carbon.

LI conducted the detailed analysis of the alternatives in accordance with the NCP, 40 CFR 300.68 (h). The full discussion is in

Table 4

SUMMARY OF COST ESTIMATES FOR THE FIVE EXAMPLE REMEDIAL ALTERNATIVES

Remedial Alternative	Capital Costs (1000's of $)	O & M Costs* (1000's of $)	Present Value** (1000's of $)
1. No Action	0	38	358
2. Surface Water and Ground Water Collection and Discharge			
a) drains only	2,036	72	2,715
b) wells only	1,104	152	2,537
3. Surface Water, Ground Water and Leachate Collection, Treatment and Discharge			
a) drains only			
(1) aeration basin	3,668	98	4,592
(2) air stripping	3,750	120	4,881
b) wells only			
(1) aeration basin	1,402	201	3,297
(2) air stripping	1,529	222	3,622
4. Slurry Wall With Surface Water and Ground Water Collection and Discharge			
a) drains only	3,131	72	3,810
b) wells only	2,199	152	3,632
5. Slurry Wall With Surface Water and Ground Water Collection and Treatment			
a) drains only			
(1) aeration basin	3,162	94	4,048
(2) air stripping	3,289	116	4,383
b) wells only			
(1) aeration basin	2,230	174	3,870
(2) air stripping	2,357	196	4,205
6. EPA Alternative	1,819	153	3,259

* Annual Cost

** Capital cost plus the present value of the O & M cost assuming a 10% interest rate and 30 year planning period.

REF: TASK 2 FS

the "Feasibility Study - Task II: Detailed Evaluation of Remedial Alternatives".

LI refined the description of the alternatives in detail, with an emphasis on the use of established technologies; detailed cost estimates; evaluation of engineering implementation, reliability, and constructibility; and assessment of the extent to which each alternative is expected to prevent, mitigate, or minimize threats to, and provide adequate protection of, public health, welfare, and the environment.

The five LI alternatives and the one EPA alternative are as follows:

Alternative 1, the no action alternative, consists of the previously installed 60-inch pressurized pipeline, continued maintenance of the pipeline, and environmental monitoring. The environmental monitoring will consist of semi-annual sampling of the surface water monitoring stations and ground-water wells shown in Figure 7 and sample analyses for the parameters shown in Table 5. The no action alternative is not recommended because it does not prevent offsite migration of contaminants and thus does not reduce the potential damages to public health, welfare, and the environment.

Alternative 2, includes the following operable units:

Surface Water Collection
- perimeter ditches around the landfill to convey runoff to Cowdrey drainage
- collection of the Cowdrey Drainage flow

Ground Water Collection
- east boundary drain or well array
- west boundary drain or well array
- off-site drain or well array south of Community Ditch
- Cowdrey drainage drain or well array (north of east boundary drain)

Landfill Improvements
- regrading and revegetation of the inactive landfill to promote runoff and minimize infiltration
- perimeter fencing

Environmental Monitoring
- surface water and ground water monitoring as described for Alternative 1

Treatment
- passive via collection of surface and ground water in a system of sedimentation/equalization basins

Figure 8 is a schematic representation of Alternative 2. Whether subsurface drains or wells are employed, the landfill will be substantially isolated from the surrounding alluvial

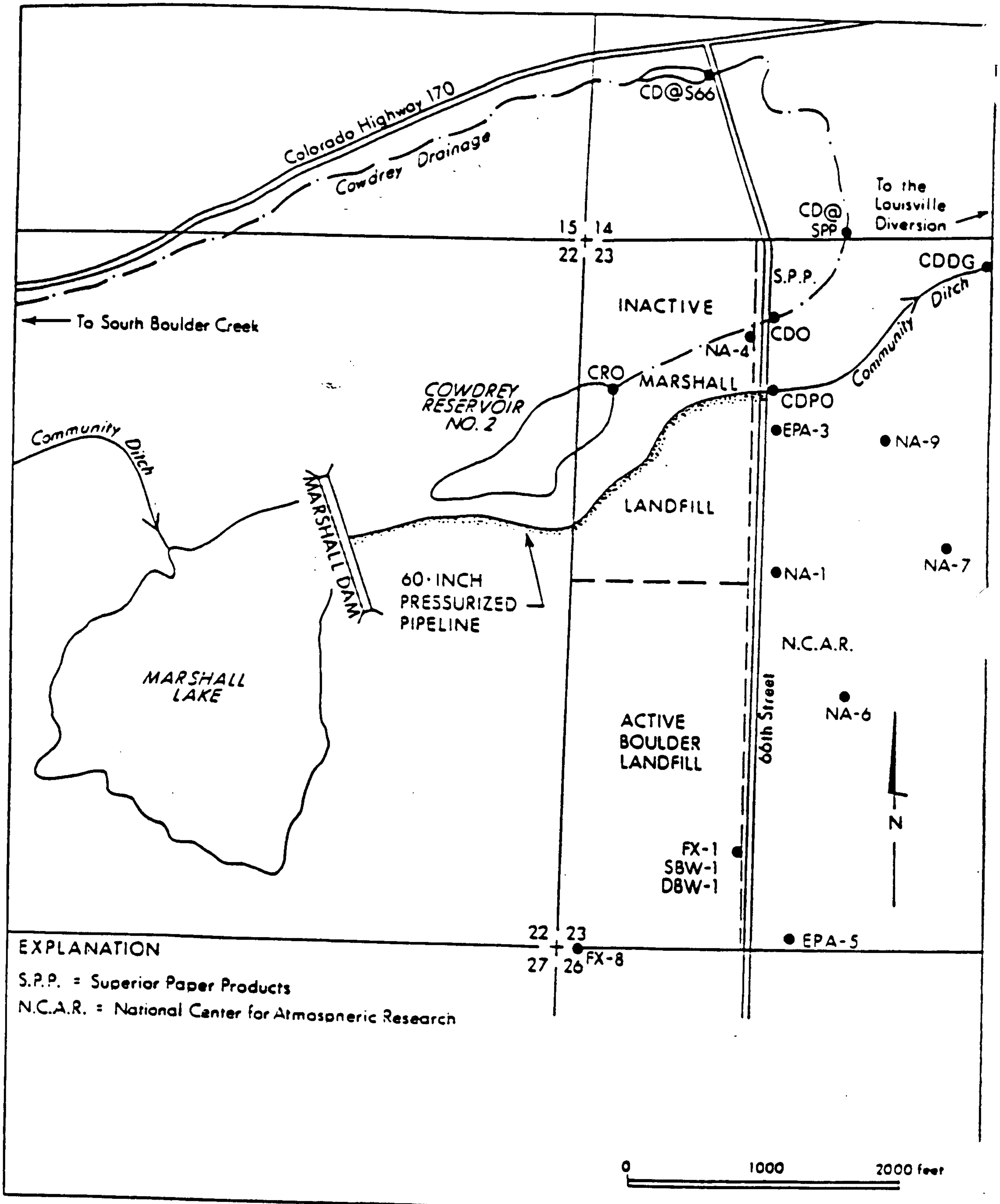


FIGURE 7 REF: FINAL FS

ALTERNATIVE 1 - NO ACTION:
ENVIRONMENTAL MONITORING NETWORK

Table 5

WATER QUALITY PARAMETERS TO BE EVALUATED UNDER THE NO ACTION ALTERNATIVE

Field Parameters

depth to water (wells only)
flow rate (surface water only)
pH
specific conductance
temperature

General Analytical Parameters

phenols
total dissolved solids
total suspended solids (surface water only)

Inorganic Parameters

sodium
potassium
calcium
magnesium
chloride
fluoride
sulfate
ammonia as N
total alkalinity as $CaCO_3$
nitrate + nitrite as N

Metal Parameters

aluminum
arsenic
barium
cadmium
chromium
copper
iron
lead
manganese
mercury
selenium
silver
zinc

Volatile Organics

benzene
bis(chloromethyl)ether
bromoform
carbon tetrachloride
chlorobenzene
2-chloroethyl vinylether
chloroform
dichlorobromomethane
dichlorodifluoromethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethylene
1,2-dichloropropane
1,3-dichloropropylene
ethylbenzene
methylbromide
methylchloride
methylene chloride
1,1,2,2-tetrachloroethane
toluene
trans-1,2-dichloroethylene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethylene
trichlorofluoromethane
vinyl chloride

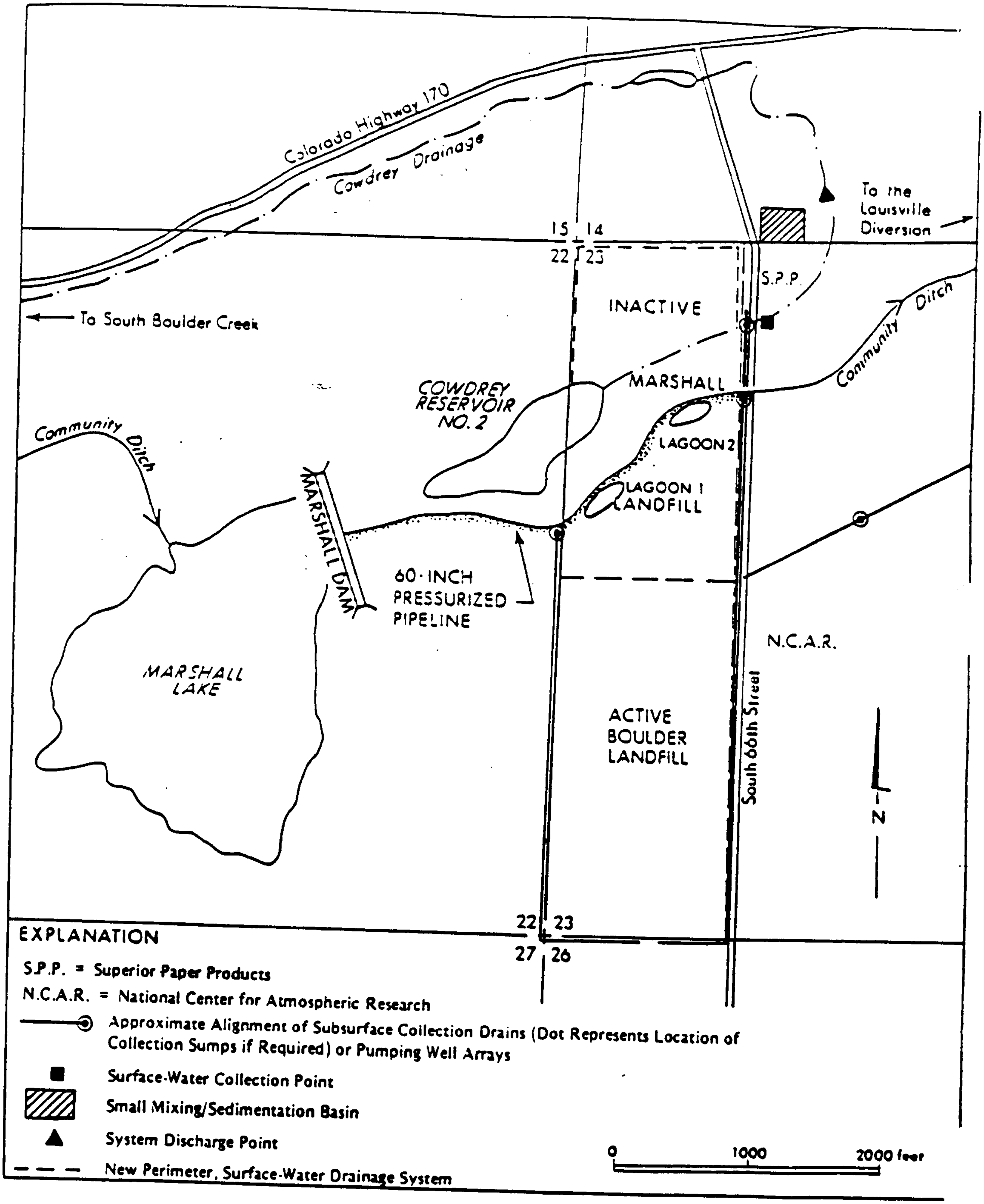


Figure 8 REF: FINAL FS

ALTERNATIVE 2 - SURFACE WATER AND GROUND WATER COLLECTION AND DISCHARGE ground water. The drains or wells would be completed to the base of the alluvium. With this alternative, contaminants may still migrate to the east via the subsurface drain beneath the pressurized pipeline and possibly to the north of the Cowdrey drain. Under this alternative, the source of contaminants will not be eliminated because the refuse will not be significantly dewatered. LI reports that this is a result of upflow from the bedrock aquifers and the low transmissivities of the alluvium. The location and effectiveness of the off-site drain is questionable because the extent and nature of off-site contamination is unknown.

The combined surface water and ground water flows collected will be passively treated by passage through a sedimentation and equalization basin resulting in some nominal reductions in contaminant concentrations. Based on the predicted quality of the effluent, a greater than 10^{-6} incremental cancer risk would be posed through lifetime ingestion of benzene, trichloroethylene, and tetrachloroethylene in the water. LI predicts the effluent concentrations to be as follows:

Compound	CRL (ppb)*	Effluent Concentration (ppb)
Benzene	0.67	1
Trichloroethylene	2.80	7
Tetrachloroethylene	0.88	27

*CRL - Cancer Risk Limit for 10^{-6} incremental cancer risk from consumption of water only (ppb).

Alternative 3, shown in Figure 9, is similar to Alternative 2 with the addition of two components. A subsurface drain would be installed in the southern portion of the inactive landfill to collect leachate, and the combined surface water, groundwater, and leachate flows would be actively treated before discharge. Although the leachate collection drain will dewater some of the refuse in the southern section of the inactive landfill, it does not provide any further containment of contaminants relative to Alternative 2. Both diffused aeration (assumed VOC reduction of 70%) and air stripping (assumed VOC reduction of 99%) were evaluated under this alternative. Only air stripping results in less than 10^{-6} incremental cancer risks with respect to lifetime ingestion of the effluent due to the presence of benzene and tetrachloroethylene. The effluent concentrations are shown below:

Compound	CRL (ppb)*	Effluent Concentration (ppb)
Benzene	0.67	2 to <1
Trichloroethylene	2.80	3 to <1
Tetrachloroethylene	0.88	11 to <1

Note: Range reflects effluent concentrations from diffused aeration and air stripping respectively.

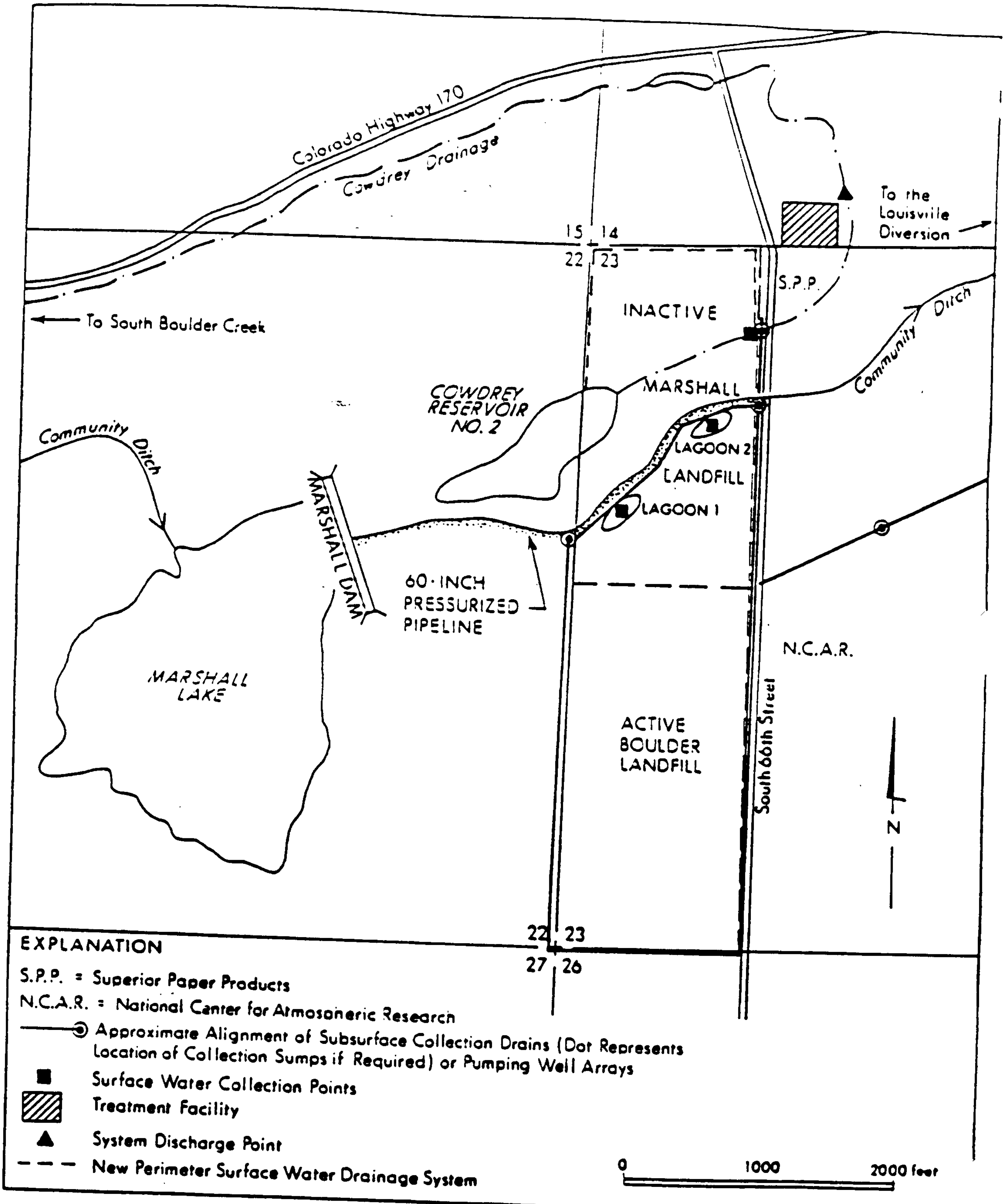


Figure 9 REF: FINAL F

ALTERNATIVE 3 - SURFACE WATER, GROUND WATER, AND LEACHATE COLLECTION, TREATMENT, AND DISCHARGE

Alternative 3 also includes landfill improvements and environmental monitoring as described for Alternative 2.

Alternative 4, (see Figure 10) is similar to Alternative 2 but includes a slurry wall around the perimeter of the landfill, and the draining and treatment of the contents of the lagoons. The lagoons would be subsequently backfilled and regraded to prevent future seeps of leachate. The French drain flow presently discharging to lagoon #1 would be routed to the sedimentation/equalization basin. Under this alternative the FS states that there would be no significantly increased drawdown of alluvial water within the bounds of the slurry wall, and thus no significantly increased dewatering of the refuse relative to Alternative 2 (no slurry wall). Removing the lagoons would eliminate possible direct exposure of the public to the contaminants contained therein. As with Alternative 2, passive treatment will not reduce the concentrations of benzene, trichloroethylene, or tetrachloroethylene to less than the 10^{-6} incremental cancer risk limits. Alternative 4 also includes landfill improvements and environmental monitoring as described for Alternative 2.

Alternative 5, (see Figure 10) is equivalent to Alternative 3 with the addition of a perimeter slurry wall. As discussed under Alternative 4, the slurry wall is not expected to increase significantly the dewatering of the refuse. As with Alternative 3, sedimentation basins and air stripping are likely to achieve an effluent meeting all applicable or relevant and appropriate standards or criteria. Alternative 5 also includes landfill improvements and environmental monitoring described for Alternative 2.

Table 6 summarizes the five alternatives of the LI FS with respect to performance, reliability, and implementability.

In addition to the five alternatives that LI developed in the FS, EPA identified another alternative. This alternative is made up of elements of the other five, successfully meets the objectives of the FS, and is consistent with the NCP, 40 CFR 300.68 (i).

Alternative 6, (see Figure 11) includes the following components:

Ground-Water Collection
- east boundary drain
- Cowdrey Drain
- south boundary drain

Treatment of Contaminated Ground Water
- sedimentation basins
- air stripper
- air stripper off-gas carbon adsorption

Environmental Monitoring
- surface water, ground water, and the treatment system

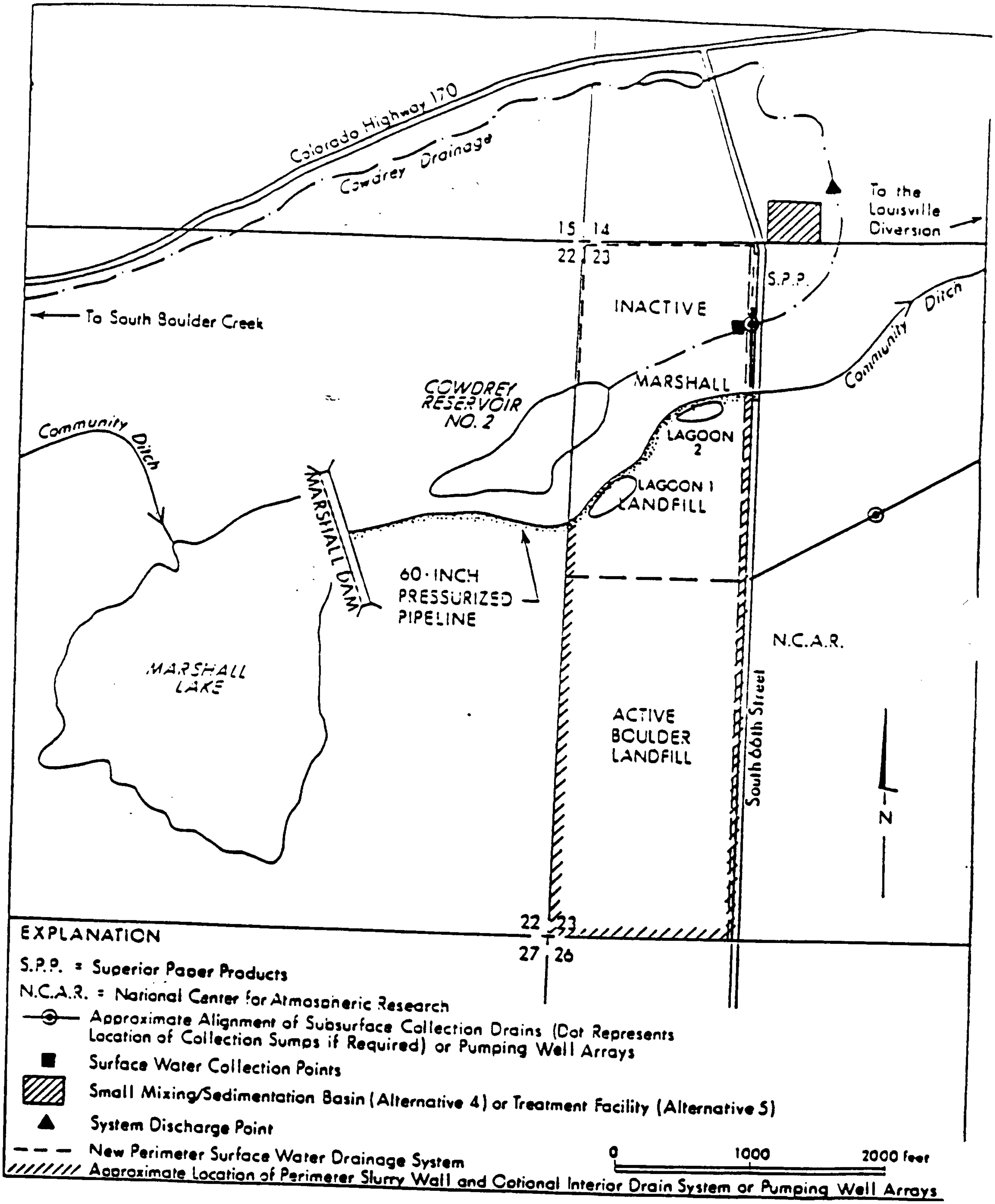


Figure 10 REF: FINAL FS

ALTERNATIVES 4&5 - GROUND WATER BARRIER WITH SURFACE WATER & GROUND WATER COLLECTION TREATMENT (Alternative 5), AND DISCHARGE

Table 6

REMEDIAL ALTERNATIVES		CRITERION			
		PERFORMANCE			
		EFFECTIVENESS			USEFUL LIFE
Remedial Alternative	Operable Unit	Source Control	Site Containment	WQ Improvement	
(1) No Action	Monitoring	None	None	None	Indefinite
(2) SW & GW Collection & Discharge	(a) West Drain	Minor Effect	Minor Effect	Moderate Effect	10-30 years
	(b) East Drain	Major Effect	Major Effect	Major Effect	10-30 years
	(c) Cowdrey Drain	No Effect	Minor Effect	Minor Effect	10-30 years
	(d) Off-site Drain	No Effect	No Effect	Minor Effect	10-30 years
	(e) Surface Water Control	Minor Effect	Major Effect	Minor Effect	10-30 years
	(f) Sed./Equal Basins	None	None	Major Effect	30 years
(3) SW, GW & Leachate Collection Treatment	(a through f)	(as above)			(as above)
	(g) Leachate Drain	Major Effect	Minor Effect	Major Effect	10-30 years
	(h) Airstripping Tower	None	None	Major Effect	30 years
(4) GW Barrier w/ SW & GW Collection & Discharge	(a through f)	(as above under Alternative 2)			(as above unde Alternative 2
	(g) Slurry Wall	Minor Effect	Major Effect	None	30 years or mor
(5) GW Barrier w/ SW & GW Collection Treatment Discharge	(a through f)	(as above under alternative 2)			
	(g)	(as above under Alternative 4)			
	(h)	(as above under Alternative 3)			
(6) EPA Alternative	(b)	Major Effect	Major Effect	Major Effect	10-30 years
	(c)	Major Effect	Major Effect	Major Effect	10-30 years
	South Drain	Minor Effect	Minor Effect	Minor Effect	10-30 years
	(h)	None	None	Major Effect	30 years

Table 6 (cont.)

REMEDIAL ALTERNATIVES		RELIABILITY		
		O & M Requirements		Possible Failure Modes
Remedial Alternative	Operable Unit	Complexity	Frequency	
(1) No Action	Monitoring	Simple	Quarterly	Off-site migration between monitoring stations
(2) SW & GW	(a) West Drain	Moderately Complex	5-10 years	-Clogging/Plugging of drain or sump -Pump failure -Freezing of transfer piping
	(b) East Drain	"	"	" "
	(c) Cowdrey Drain	"	"	" "
	(d) Off-site Drain	"	"	" "
	(e) Surface Water Control	Simple	2-5 years	-Channel erosion/sedimentation -Failure of sump pump -Erosion around and by-passing of sump
	(f) Sed./Equal Basins	Simple	1-2 years	-Insufficient retention time for complete sediment removal -Insufficient agitation for significant reduction in volatile organics -Contrast between quiescent and turbulent conditions required for sediment vs. VOC control
(3) SW, GW & Leachate Collection Treatment	(a through f)	(as above)		(as above)
	(g) Leachate Drain	Moderately Complex	5-10 years	
	(h) Airstripping Tower	Moderately Complex	Daily or Weekly	-Power failure -Plugging of packing material by sediment or precipitates -Chemical changes (i.e., pH) -Incomplete removal of organics
(4) GW Barrier w/ SW & GW Collection & Discharge	(a through f)	(as required under Alternative 2)		-(as above)
	(g) Slurry Wall	None Required		-Chemical breakthrough by incompatible leachates -Underflow beneath slurry wall (i.e., foundation failure)
(5) GW Barrier w/ SW & GW Collection Treatment and Discharge	(a through f)	(as above under Alternative 2)		
	(g)	(as above under Alternative 4)		
	(h)	(as above under Alternative 3)		
(6) EPA Alternative	(b)	Moderately Complex	5-10 years	-Clogging, pump failure, freezing
	(c)	" "	"	" "
	South Drain	" "	"	" "
	(h)	" "	Daily or weekly	-Power failure, plugging, chemical changes -Incomplete remova[illegible]ganics

Table 6 (cont.)

REMEDIAL ALTERNATIVES		CRITERION: IMPLEMENTABILITY		
Remedial Alternative	Operable Unit	Constructability	Time	Safety Considerations
(1) No Action	Monitoring	System already in place	1 month	None
(2) SW & GW	(a) West Drain	Straightforward	12 months	-Sidewall stability -Exposure to contaminated GW
	(b) East Drain	Difficult along southern portion due to the depth to bedrock		-Severe sidewall stability problems -Exposure to contaminated GW -Traffic congestion along S. 66th St.
	(c) Cowdrey Drain	Straightforward		-Exposure to contaminated GW
	(d) Off-site Drain	Major difficulty due to the depth to bedrock		-Severe sidewall stability problems
	(e) Surface Water Control	Straightforward		-Exposure to contaminated GW
	(f) Sed./Equal Basins	Straightforward		None
(3) SW,GW & Leachate Collection Treatment	(a through f)	(as above)	15 months	-(as above)
	(g) Leachate Drain	Straightforward		-Exposure to very contaminated leachate
	(h) Airstripping Tower	Straightforward		-Impact of air emissions on surrounding area
(4) GW Barrier w/ SW & GW Collection & Discharge	(a throuhgh f)	(as above under Alternative 2)	16 months	-(as above under Alternative 2)
	(g) Slurry Wall	Major difficulties anticipated due to limited space available and lack of suitable foundation materials		-Traffic congestion along S. 66th St.
(5) GW Barrier w/ SW & GW Collection Treatment and Discharge	(a through f)	(as above under Alternative 2)		
	(g)	(as above under Alternative 4)		
	(h)	(as above under Alternative 3)		
(6) EPA Alternative	(b)	Difficult along Southern portion	15 months	See (2) above
	(c)	Straightforward	15 months	"
	South Drain	Difficult along Eastern portion	15 months	"
	(h)	Straightforward	15 months	None

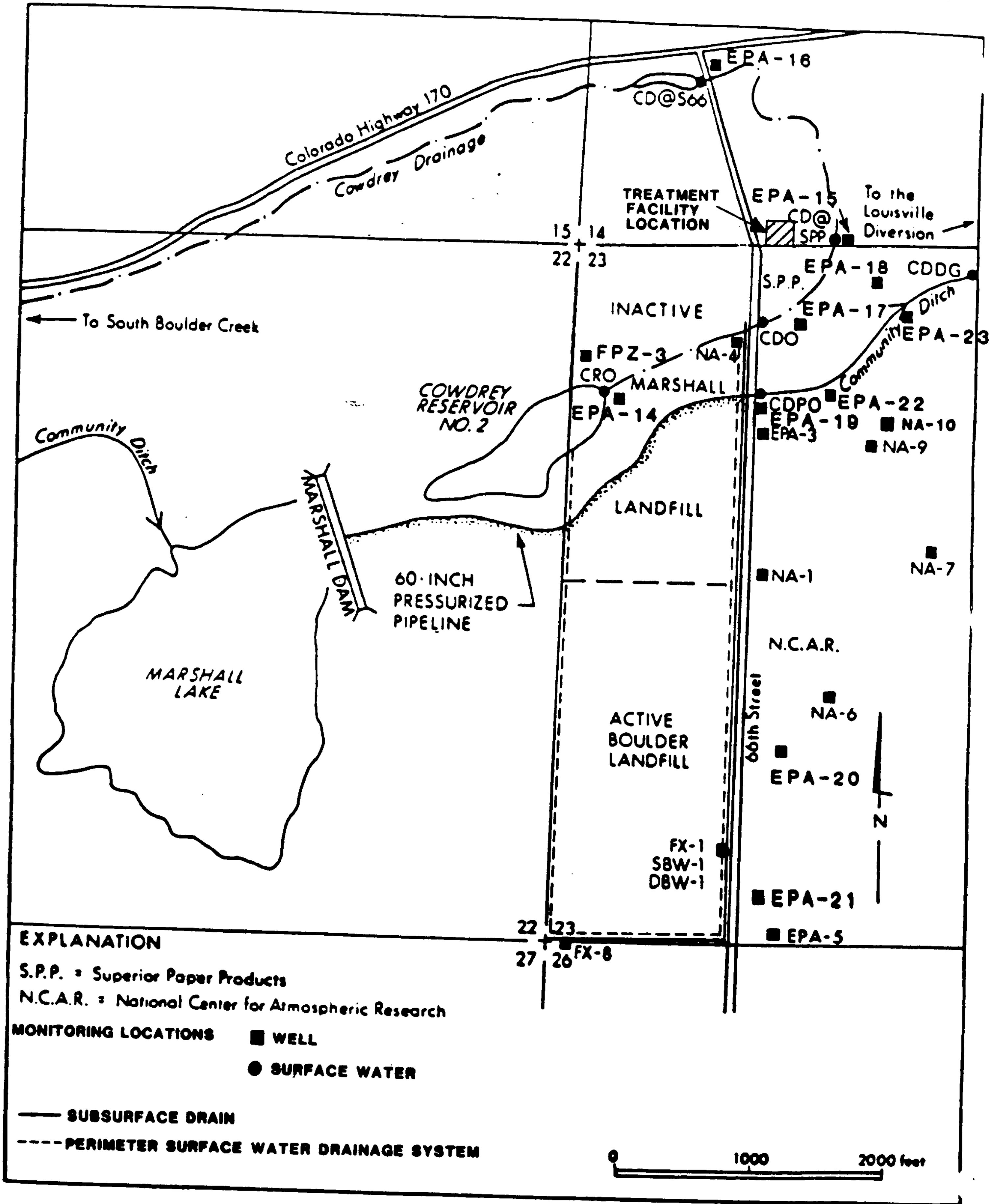


FIGURE 11

ALTERNATIVE 6 - EPA ALTERNATIVE

will be monitored

Landfill Improvements
- perimeter ditches around the landfill
- drain the lagoon
- regrade and revegetate the inactive landfill to promote runoff and minimize infiltration
- perimeter fencing

This alternative is expected to capture the contaminated ground water migrating from the site and treat it by means of sedimentation and air stripping so that the effluent will attain all applicable or relevant and appropriate water quality standards or criteria. Under this alternative, the source of contaminants (the refuse) will not be eliminated because the refuse will not be significantly dewatered. However, according to the LI FS, dewatering the landfill may not be practicable due to the upflow from the bedrock aquifers and the low transmissivities of the alluvium.

Under this alternative, surface water leaving the site will not be collected or treated. During the RI, analyses of surface water at the site boundary showed no contamination.

To meet other appropriate environmental laws (RCRA for this site), design for elements of this alternative - the draining of the lagoons, sedimentation basins, treatment system, associated piping, and off-site ground water will take into account the RCRA requirements. This will be discussed more fully in the section Consistency with Other Environmental Laws.

Table 6 also summarizes the EPA alternative with respect to performance, reliability, and implementability.

COMMUNITY RELATIONS

EPA placed the RI/FS report submitted by LI in six information repositories in metropolitan Denver and Boulder County. The three week public comment period started on February 25, 1986, and culminated with a public hearing held on March 18, 1986 to receive questions, position statements, and comments from the public on the draft RI/FS.

The majority of the comments on the RI/FS came from the CDH, BCHD, and the Boulder County Public Works Department (BCPWD). CDH commented on the need for: 1) an expanded and improved monitoring system; 2) treatment facility in compliance with RCRA design standards; 3) air stripping as opposed to aeration as the primary treatment process; 4) reevaluation of the slurry wall; and 5) completion of the public health evaluation. The BCHD also commented on the need for expanded monitoring, air stripping, and reevaluation of the slurry wall. The BCPWD emphasized the terms of the Cooperative Agreement especially as it related to LI's responsibility in the financing of remedial action at the site. The CDH and BCHD technical comments have been addressed in the Agency's preferred alternative. Two private citizens expressed the opinion that the objectives of the FS do not address the potential for contamination of the bedrock aquifers. Also a private citizen questioned the validity of the calibration period for the ground water model which is the primary tool used by LI to evaluate technically the effectiveness of the various alternatives.

Following the public comment period, EPA prepared a responsiveness summary for the comments received. Both the responsiveness summary and a transcript of the public meeting were placed in all six repositories.

EPA shares the concerns expressed by the private citizens and local and state governments. These concerns are addressed in the Recommended Alternative section. Note especially the discussion of additional field testing and analysis pertaining to the slurry wall.

CONSISTENCY WITH OTHER ENVIRONMENTAL REQUIREMENTS

Section 300.68(j) of the NCP requires that the lead agency select a cost-effective remedy that effectively mitigates and minimizes threats to and that provides adequate protection of public health, welfare and the environment. This requires selection of a remedy that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements identified for each specific site. EPA has determined that the following applicable or relevant and appropriate standards apply to the Marshall Landfill site:

Safe Drinking Water Act: Maximum Contaminant Levels (MCLs), Recommended Maximum Contaminant Levels (RMCLs)

Clean Water Act: point source control; water quality standards

Clean Air Act: stationary source of volatile organics

Resource Conservation and Recovery Act (RCRA): ground-water monitoring and corrective action; site access restrictions; runon/runoff controls, secondary containment and leak detection for surface impoundments and tanks and associated piping.

In evaluating the alternatives, EPA has determined that the recommended alternative would comply with these standards as follows:

Safe Drinking Water Act: MCLs and RMCLs are among the criteria used to establish the effluent standards for both the treatment facility and the target off-site ground-water quality concentrations.

Clean Water Act: EPA met with representatives of CDH Water Quality Division at which time EPA was made aware of CDH's requirement for a Colorado Pollution Discharge Elimination System (CPDES) permit for the treatment facility. The State intends to require that LI obtain a CPDES permit. The facility effluent will have to comply with Colorado stream standards for the mainstem of South Boulder Creek and other water quality standards as determined by CDH for toxic pollutants.

Clean Air Act: CDH determines the need and thus the requirement for emission controls for the release of toxic, hazardous, or odiferous compounds on the basis of:

1) odors at the site boundary;
2) maximum ground level concentrations greater than the Threshold Limit Value (TLV) divided by 420 (a factor currently used by the state of Massachussetts and under consideration by CDH);
3) the existence of reasonable available control technology (RACT);
4) the economic burden of installing RACT.

Until CDH is notified of the expected emission and has analyzed the emission data, the requirement for emission controls cannot be determined. The proposed off-gas carbon system represents RACT and is included in the recommended alternative to prevent transferring hazardous substances from one environmental medium to another. EPA has met with CDH and informed them that an air stripper tower is being considered at the Marshall Landfill.

Resource Conservation and Recovery Act: The boundary of the site will be considered the compliance point for ground water monitoring and corrective action. The surface impoundments and piping will have secondary containment which also will provide for leak detection. The perimeter ditches will provide runon/runoff controls. The facility will meet 40 CFR 264 Subpart B General Facility Standards, Subpart C Preparedness and Prevention, Subpart D Contingency Plan and Emergency Procedures, and Subpart E Manifest System, Recordkeeping, and Reporting. Spent off-gas carbon and sludges dredged from the sedimentation ponds will be handled and treated/disposed as hazardous waste.

RECOMMENDED ALTERNATIVE

Section 300.68 (i) of the NCP (40 CFR Part 300), states that the appropriate extent of remedy shall be determined by the lead agency's selection of a cost effective remedial alternative that effectively mitigates and minimizes damage to and provides adequate protection of public health and welfare and the environment. Except for reasons of fund-balancing difficulties, technical impracticality, or unacceptable environmental impacts, this will require selection of a remedy that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements.

EPA's recommended alternative consists of selected operable units that comprise the five alternatives evaluated by LI. This alternative is consistent with 40 CFR 300.68 (i).

Ground Water Collection

To eliminate offsite transport of contaminants via alluvial ground water, a drain or series of drains will be constructed along the entire eastern and southern boundaries of the 160-acre site. These two directions were chosen because of the migration patterns identified by the RI. EPA did not include a west drain in the recommended alternative because it would not improve source control relative to the performance of the combined south and east drains. EPA did not include a north drain because ground water moving north eventually intersects Cowdrey Drainage. Cowdrey Drainage underflow will be collected by the east drain.

The drain will consist of 3 to 5 foot wide trenches excavated one foot into bedrock and containing drain pipe and gravel.

As shown in Figure 12, a 6-inch layer of fine gravel in the base of the trench will provide the bedding for the 6-inch perforated (or slotted) drain pipe. The trench will then be backfilled with three-quarter inch gravel to approximately the maximum water table level. If deemed necessary during the remedial design phase, the trench will be lined or the drain pipe wrapped with filter fabric to reduce blinding of the collection system. The remainder of the trench will be backfilled with compacted fill originally removed during the excavation. The drain will follow the natural grade of the bedrock. Sumps will be installed where required for gravity collection of ground water.

The sumps will be constructed from 6-foot sections of 60-inch steel reinforced concrete sewer pipe, installed vertically with a 6-inch thick concrete floor. An alternating duplex pump system will be installed in each sump to remove collected ground water. The pumps will operate intermittently in response to signals from float type level controls within the sump. Ground water will then be pumped to the onsite treatment facility via 4-inch buried PVC pipe.

EPA and LI's estimates for a drain system show it to be more costly than a well array designed to serve the same purpose. The drain is still preferred. The drain will require significantly less maintenance. If well spacing to achieve flow convergence has been overestimated in the FS, then the cost of the well array system could increase significantly. Also, a lower discount rate or longer planning horizon would tend to narrow the difference in the present value of each option. At this time, the lower operation and maintenance costs associated with the drain system

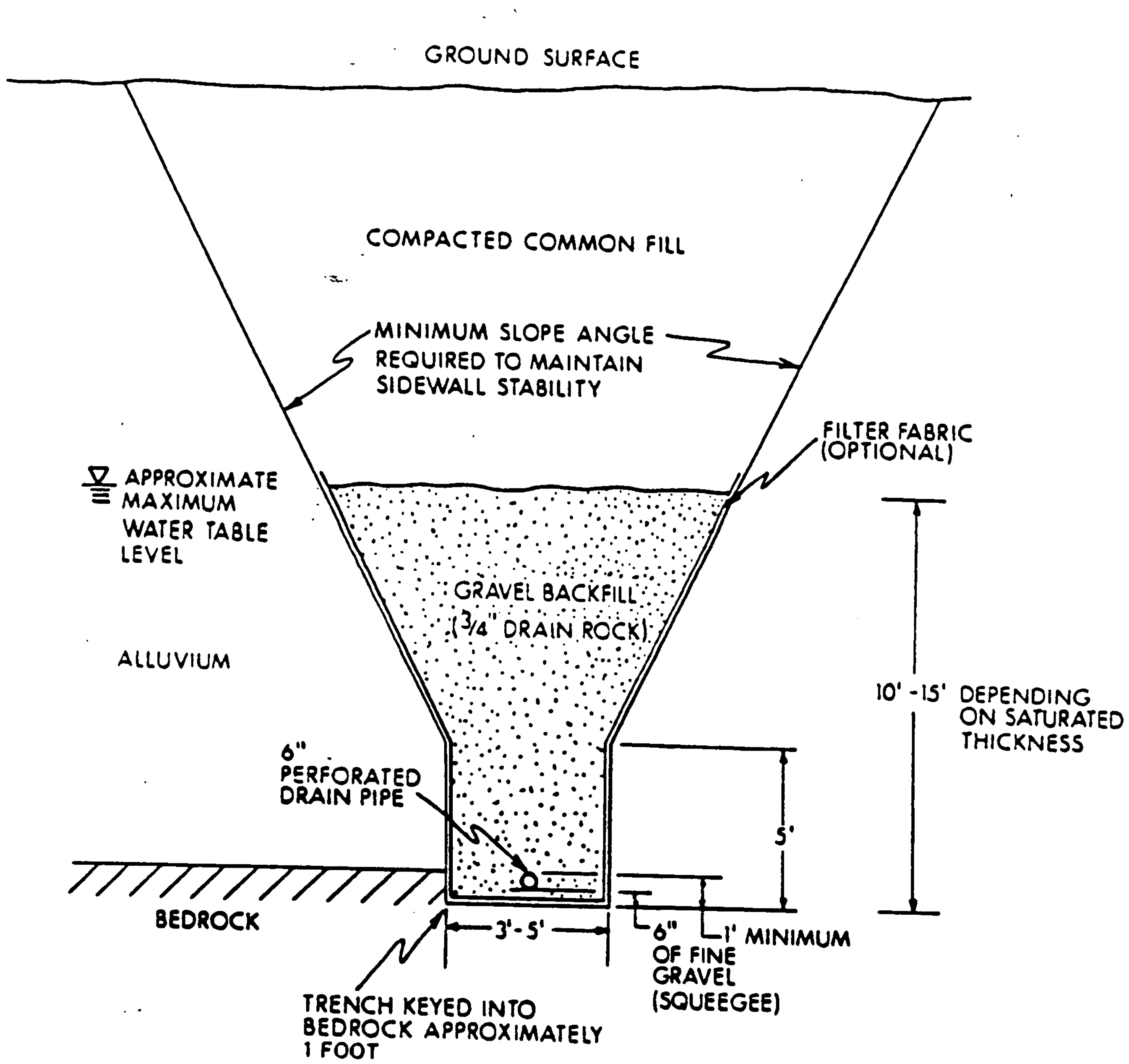


FIGURE 12

REF: FINAL FS

Typical Cross Section of Subsurface Collection Drain

is a primary factor leading to its inclusion in the recommended alternative.

RCRA design standards are relevant and appropriate standards for the ground water collection program. Pursuant to these requirements, the ground water collection system will be the compliance point for ground water corrective action. The intent of ground water collection is to prevent further migration of contaminants in the alluvial ground water from the 160-acre site. This in turn should result in improvement of ground water quality east of the site, the target quality being the effluent standards for the on-site treatment facility (see Table 7).

The time period for evaluating the effectiveness of the ground water collection system is three years. This time is based on the horizontal flow rates through the alluvial aquifer. If significant improvement of ground water quality east of the 160-acre site is not achieved within the three years after the installation of the collection system, then further corrective action will be considered and implemented as appropriate.

LI has provided data in the FS indicating insignificant incremental dewatering of the refuse within the 160-acre site resulting from the installation of a slurry wall with interior drain relative to drains alone. EPA's position is that the FS analysis is inadequate and that further work is necessary to evaluate the possible technical merits of including a slurry wall in the preferred alternative. Therefore, further examination is needed to evaluate the slurry wall in terms of its potential to:

1. reduce the contaminant sources and effectively contain contaminants on-site (the slurry wall will provide secondary contaminant with respect to the interior well/drain system);

2. reduce long term operation and maintenance costs relative to a simple drain collection system (as proposed here) by reducing the initial and long term flow of water requiring treatment; and

3. reduce the potential for deep aquifer contamination by reducing the potentiometric head difference between the alluvial and deep bedrock ground waters.

Evaluation methods will include field testing and geohydrologic modeling to determine the magnitude and areal extent of vertical flows between the alluvial and underlying aquifers, and the physical properties of the foundation layer for the slurry wall. This evaluation will be done during the Remedial Design phase. Should the results of this evaluation indicate this remedial action to be more favorable than the recommended alternative without it presented here, the remedial action will be modified to incorporate a slurry wall.

Treatment of Contaminated Water

Contaminated water collected at the Marshall site will be treated to achieve an effluent quality that meets all applicable or relevant and appropriate standards and criteria. These include Recommended Maximum Contaminant Levels (RMCLs), Maximum Contaminant Levels (MCLs), Clean Water Act Water Quality Criteria, Suggested No Adverse Response Limits (SNARLs), Adjusted Accepted Daily Intakes (AADIs), and Colorado Stream Standards. These standards and criteria are presented in Table 7 along with the effluent standard which represents the most conservative of the criteria.

The effluent standard will be achieved by treating collected ground water in a facility consisting of equalization/sedimentation basins, air stripper, and air stripper off-gas carbon adsorption. The facility will be located on Cowdrey property east of South 66th Street. Effluent will be discharged to Cowdrey Drainage. The effluent will meet CPDES permit requirements to be set by the State of Colorado. The facility will meet applicable RCRA standards identified at 40 CFR 264.

The surface impoundments will consist of a 10 foot by 10 foot catch basin to receive ground water from the collection system followed by a 25 foot by 25 foot equalization/sedimentation basin. The basins will be 4 feet deep, and double lined with a leak detection system between the liners. The liner material will be compatible with the constituents of the ground water. All underground piping will be double piped for leak containment and leak detection.

The air stripper will be designed and operated to achieve the effluent standards for the volatile organics. The discharge from the off-gas carbon system will contain non-detectable concentrations of the volatile organics. The off-gas discharge will be monitored to demonstrate attainment of this standard and to verify adequate maintenance of the off-gas system in accordance with manufacturer recommendation. Spent carbon from the air stripper will be thermally regenerated to destroy the adsorbed hazardous constituents.

The effluent standards for inorganic parameters are largely set by the South Boulder Creek instream water quality standards. It is likely the influent inorganic quality to the treatment system will comply with these standards. One possible exception may be iron (predicted effluent concentration = 1.2 mg/l), in which case chemical addition may be required to facilitate additional precipitation in the equalization/sedimentation basins.

The treatment system will be operated until the effluent standards specified in Table 7 are met by the collected ground water or until such time that EPA determines that the collected ground water no longer adversely affects water quality.

TABLE 7

APPLICABLE OR RELEVANT AND APPROPRIATE WATER QUALITY STANDARDS AND CRITERIA

	Stream Standards[1]	MCLs[2]	RMCLs[3]	WQC[4]	SNARLs[5]	AADI[6]	Treatment Effluent Standards[7]
Total Dissolved Solids	-	500 mg/l	-	-	-	-	500 mg/l
Chloride	250 mg/l	250 mg/l	-	-	-	-	250 mg/l
Sulfate	250 mg/l	250 mg/l	-	-	-	-	250 mg/l
Ammonia	20	-	-	-	-	-	20
Nitrate	10 mg/l	10 mg/l	10 mg/l	-	-	10 mg/l	10 mg/l
Arsenic	50	50	50	0(0.0025)**		100	0***
Barium	-	1000	1500	-	-	1800	1000
Cadmium	0.6	10	5	10	-	18	0.6
Chromium	50 (25)*	(50)*	120	(50)*	-	170	25*
Copper	7	-	1300	1000	-	1300	7
Iron	300	-	-	-	-		300
Lead	4	50	20	50	-		4
Manganene	50	-	-		-	-	50
Mercury	0.05	2	3	10	-	5	0.05
Nickel	50	-	-	15.4	-	-	15.4
Selenium	10	10	45	10	-	106	10
Silver	0.1	50	-	50	-	-	0.1
Zinc	50	-	-	5000	-		50
Phenols	-	-	-	3500	-		3500
1,1-Dichloroethane	-	-	-	(0.94)***	-		0***
trans 1,2-Dichloroethylene	-	-	70	-	-	350	70
1,1,1-Trichloroethane	-	-	200	19,000	1000		200
Tetrachloroethylene	-	-	-	0(0.88)**	20		0***
Dichloroethylene	-	-	-	0(0.033)**	70		0***
Ethylbenzene	-	-	680	2400	-	3400	680
Toluene	-	-	2000	15,000	340	10,100	340
Benzene	-	-	0	0(0.67)**	70		0***
Trichloroethylene	-	-	0	0(2.8)**	75		0***

(Table 7 continued)

Table 7 (continued)

1 Colorado Stream Standards are set for specific bodies of water. The standards shown here are for the mainstem of South Boulder Creek from the head waters to South Boulder Rd. These standards apply to Cowdrey Drainage which is a tributary to South Boulder Creek

2 Maximum Contaminant Levels (MCLs) were formulated under the Safe Drinking Water Act as the allowable levels in public water supplies. The levels generally considered lifetime exposure from a number of sources, including air, water, and food, when calculating the allowable levels for drinking water. These levels considered health factors and the economic feasibility of removing each contaminant from the drinking water.

3 Recommended Maximum Contaminant Levels - The EPA has developed and proposed Recommended Maximum Contaminant Levels pursuant to the Safe Drinking Water Act. They are guidelines for drinking water quality rather than standards, and are based entirely on health considerations.

4 Water Quality Criteria - The Clean Water Act (CWA) Water Quality Criteria were developed under Section 303c of the CWA to protect the beneficial uses of a water body. The criteria shown here are non-enforceable but are intended as guidelines for the protection of human health from lifetime exposure of drinking the water.

5 Health Advisories (SNARLS) - The Health Advisories or Suggested No Adverse Response Limits (SNARLS) are guidelines developed by the Office of Drinking Water. They were formulated to provide guidance levels for chemicals not routinely found in water supplies. The guidelines used here are for long term exposure (in terms of weeks or months) to a 1-year-old infant. A safety margin has been incorporated into the levels. The SNARLS do not incorporate carcinogenic risks or the synergistic effects of chemicals.

6 Adjusted Accepted Daily Intake (AADI) - EPA formulated the Adjusted Acceptable Daily Intake levels based on toxicological literature. The observed no adverse effect level, reported in mg/kg/day, is adjusted by a safety factor to give an acceptable daily intake (ADI). The ADI is converted to an acceptable concentration in water (the AADI) by assuming a daily intake of water by an adult of average weight. The AADIs are limits for toxic effects and do not consider carcinogenicity.

7 Treatment Effluent Standards are for the groundwater treatment facility and represent the most conservative of the applicable, relevant, and appropriate standards.

(Table 7 continued)

Table 7 (continued)

NOTE: All concentrations are expressed in ug/l unless indicated otherise

* Standard for hexavalent chromium

** 10^{-6} increased cancer risk for drinking water only

*** The suggested cleanup standards are 0 because this compound is a carcinogen. Cleanup will be assumed complete with respect to these compounds when they are below the method detection limit defined by the EPA Contract Laboratory Program.

**** This standard is for 1,2 - dichloroethane and represents the 10^{-6} increased cancer risk for drinking water only. This standard is used for 1,1 - dichloroethane because of the chemical similarity of the two compounds and the lack of specific criteria for 1,1 - dichloroethane.

Monitoring

An environmental monitoring program will be implemented to verify the effectiveness of the remedial action and to assure protection of public health. The monitoring program will provide data to evaluate the performance of the treatment and collection systems and the sources and movement of contamination east of South 66th Street. The monitoring network will include at the minimum the ground water wells and surface water locations shown in Figure 11. The rationale for selection of these stations is as follows:

1. Operational Monitoring
   a. ground water drawdown and quality adjacent to the east drain
   - NA-4, EPA-19, EPA-3, NA-1, EPA-20, EPA-21, FX-1,
   b. flow and water quality influent to the equalization/sedimentation basins (not shown in Figure 11)
   c. flow and water quality influent to the air stripper (not shown in Figure 11)
   d. flow and water quality of the effluent from the treatment facility (not shown in Figure 11)

2. Surface Water Quality in Cowdrey Drainage
   - CRO, CDO, CD@SPP, CD@S66

3. Surface Water Quality in Community Ditch
   - CDPO, CDDG

4. Ground water Quality and Potentiometric Surface Along Community Ditch
   - EPA-18

5. Ground water Quality and Potentiometric Surface in Cowdrey Drainage Alluvium
   - FPZ-3, NA-4, EPA-14, EPA-15, EPA-16, EPA-17

6. Ground water Quality and Potentiometric Surface East of Active and Inactive Landfills
   - NA-6, NA-7, NA-9, NA-10

7. Ground water Quality and Potentiometric Surfaces for the Alluvium, Shallow Bedrock Aquifer, and Deep Bedrock Aquifer
   - FX-1, SBW-1, DBW-1

8. Background Ground water Quality
   - EPA-5, FX-8

Monitoring will be on a frequency consistent with the objectives of the monitoring program. Initially ground water levels will be measured monthly until levels reach equilibrium; subsequent measurements will coincide with the sampling of ground water wells and surface waters. The wells and surface water sampling locations will be sampled quarterly for one year, and semi-annually in subsequent years. Operational monitoring with respect to the treatment system will be conducted weekly until data indicate a lower frequency would be adequate. Samples will be analyzed for the parameters identified in Table 5.

A thirty year planning horizon is used here as the time period for estimating monitoring expenses. The actual aquifer clean-up ultimately will dictate whether monitoring can cease within the thirty year planning horizon or will need to continue longer.

The off-site monitoring well data will be used to determine if additional response actions are necessary to protect public health, welfare and the environment. Such a determination will be made as appropriate in a subsequent decision document.

As shown in Table 8, the estimated capital cost for the recommended alternative is $1,819,000. The cost takes into consideration all elements of the landfill improvements, ground water collection system, ground water treatment system, and monitoring program. O&M costs are estimates for the initial years. Reduction of environmental monitoring in subsequent years will reduce this figure.

<u>Landfill Improvements</u>

The perimeter of the site will be fenced with a three strand barbed wire fence approximately four feet in height. The fence will keep cattle off the site and restrict public access to the site. Signs which are legible from a distance of 25 feet will be posted in sufficient numbers around the site to be seen from any approach to the site. The signs will state "Danger--Unauthorized Personnel Keep Out". All signs will be printed in English and Spanish.

The existing leachate collection lagoons will be drained and the lagoon liquid contents transferred to the on-site treatment system. Should the quality of the lagoon contents be considered unacceptable for on-site treatment, necessary approvals for final disposition of the lagoon water will be secured. The lagoons will then be backfilled and the area regraded to achieve a final slope of 13%. Should leachate surface after regrading the area, additional grading or other actions as might be necessary will be performed to eliminate completely surface seeps of contamination.

The lagoons will be closed in compliance with the standards specified in RCRA, 40 CFR 264.228. The ground water collection system and off-site environmental monitoring will provide additional assurance to the closure of these lagoons.

The French drain discharge that is currently received by lagoon #1 will be redirected to the treatment facility.

Surface water in Cowdrey Drainage will otherwise not be collected and treated. Further corrective actions will be considered in an additional decision document if hazardous substances, pollutants,

TABLE 8

ESTIMATED COSTS OF RECOMMENDED ALTERNATIVE

Operable Unit	Capital Costs $	Annual O&M Costs $	Present Value* $
1. Perimeter Ditches	35,000	1,500	49,000
2. Ground water Collection Drain	1,372,000	5,000	1,419,000
3. Equalization Basins	50,000	15,100	192,000
4. Regrading & Revegetation	190,000	0	190,000
5. Perimeter Fencing	7,000	0	7,000
6. Environmental Monitoring	7,000	87,500**	832,000
7. Air Stripping	158,000	43,700	570,000
TOTALS	1,819,000	152,800	3,259,000

* Present value equals the capital cost plus the present value of the annual operation and maintenance cost calculated based on a 10% interest rate and 30 year planning horizon.

** 27 surface water, and ground water, sampling stations X 2 analyses/yr X $750/analysis = $40,500. Labor estimated at $20,000. First year environmental monitoring will require twice this expenditure as quarterly monitoring is required. For cost estimating purposes, operational monitoring with respect to the treatment facility is assumed to be conducted on a frequency of once per month; 3 sampling locations X 12 analyses/yr X $750/analysis = $27,000.

or contaminants are subsequently detected during environmental monitoring of the surface water leaving the 160-acre site.

The entire 160-acre site will be regraded and seeded to promote runoff and thus minumize infiltration. Regrading will include elimination of depressions where water can accumulate, and the application of at least six inches of soil to the regraded surface. The soil will be subsequently seeded with native grass. Perimeter ditches will be installed along the landfill south of Cowdrey Drainage.

As the Marshall Landfill is still in operation, a cap is not included in the preferred alternative. However, the objectives of the cap, as stated in RCRA, 40 CFR 264.310 will be met:

1. Minimization of migration of liquids through the landfill will be achieved by final cover, regrading, revegetation, the perimeter ditches, and the subsurface drain.

2. The regrading and revegetation along with perimeter fencing will minimize maintenance costs.

3. Drainage will be promoted by regrading; revegetation and regrading will minimize surficial erosion.

4. Annual maintenance will assure the integrity of the final cover.

5. Infiltration is a minor component of the water balance as discussed in the Task 3 Addendum of the RI.

OPERATION AND MAINTENANCE

The preferred alternative will require on a routine basis environmental monitoring, maintenance of the ground water collection system and operation and maintenance of the ground water treatment facility. The environmental monitoring has been previously described and consists of operational monitoring and monitoring to evaluate the effectiveness of the remedial action and the protection of public health. A thirty year time frame for these activities has been used for estimating purposes. However, the actual time period for operation and maintenance depends on the site conditions. The ground water collection system will require periodic inspection and cleaning when necessary. The ground water treatment system will require regular attendance for operations and maintenance. Maintenance will include periodic removal of the packing material in the air stripper or in-place cleaning of the packing. The off-gas carbon system will require routine monitoring and replacement of the carbon as necessary to maintain performance. The equalization/sedimentation basins will require periodic dredging to remove accumulated solids. The annual cost for operation and maintenance is estimated at $152,800. The present value of this cost over 30 years is $1,440,000.

SCHEDULE

4Q FY 86 - Regional Administrator signs EDD
x - Resolution of Enforcement Activity
x + 1 month - Start Design
x + 10 months - Complete Design
x + 12 months - Start Construction
x + 25 months - Complete Construction

FUTURE ACTIONS

Results of monitoring off-site ground water may indicate that further response actions are needed. As stated in the recommended alternative, if significant improvement of off-site ground water quality is not observed in three years after implementation of the selected remedial action, than further action will be considered as necessary.